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NDL-TR-32

Cold Weather Decontamination Study - McCoy II

by

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and

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GENERAL DYNAMICS/FORT WORTH

July 1962

U. S. ARMY
NUCLEAR DEFENSE LABORATORY
ARMY CHEMICAL CENTER • MARYLAND

CLEARANCE CERTIFICATE

1. Title: "Cold Weather Decontamination Study - McCoy II."

2. Full Names of Authors: Joseph C. Maloney
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James Barnard
Charles C. Kilmer

3. Installation of Origin: U. S. Army Nuclear Defense Laboratory
Army Chemical Center, Maryland

4. Project Number and Title Related to Material to be Cleared:

4X12-01-001-02, Decontamination

5. Proposed place of publication: ASTIA, Arlington, Virginia and subsequently to OTS, Department of Commerce.

6. Statements of Certification:

a. Publication or presentation outside the United States is contemplated.

b. "In my opinion this material does not contain matter that should be patented, and its release to the public will not aid interests adverse to the national defense of the United States."

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CBR AGENCY CLEARANCE ITEM NUMBER 70

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FOREWORD

This is the second and final report on cold weather radiological decontamination. The first report was "Cold Weather Decontamination Study - McCoy I", NDL-TR-24.

The work was authorized under Army funded Project 4X12-01-001-02, Decontamination (U), with equal funding furnished by the U. S. Navy Bureau of Yards and Docks. The work was started in December 1961 and was completed in February 1962.

Acknowledgements

The authors wish to acknowledge the assistance of the staff of Camp McCoy, Wisconsin, who provided timely logistic and maintenance support at the test site, and of personnel of Mobile Construction Battalion Four, U. S. Navy, Davisville, Rhode Island, and the Fifth Engineer Battalion, Fort Leonard Wood, Missouri, who performed the recovery exercise on a living-quarters complex. In addition, appreciation is given to Mr. A. E. Hanna of the U. S. Naval Civil Engineering Laboratory, Port Hueneme, California, for his assistance at the test site.

Notices

Disposition

DIGEST

Experiments were conducted to collate data pertinent to radiological decontamination under cold-weather conditions, so that the necessary data would be available for publication of a cold-weather addendum to the Departments of the Army and Navy technical manual TM 3-225 (NAVDOCKS TP-PL-13), Radiological Recovery of Fixed Military Installations.

A series of fallout decontamination tests was conducted in the temperature range of -10°F to +32°F at Camp McCoy, Wisconsin, on appropriate winter surfaces using maintenance, snow-removal, and fire-fighting equipment. Following this, a contingent of 24 troops decontaminated a 3½-acre living quarters complex as a logistic exercise. Tests were also conducted on the migration of fallout deposited on ice and snow, and the shielding effects of ice and snow cover.

Proper weather conditions were experienced at the test site and the following findings were made:

(1) Decontamination of hard surfaces by sweeping and hosing under cold weather conditions were of comparable effectiveness to temperate weather conditions.

(2) Decontamination of snow required removal by plowing, grading, scraping, or hosing. Packed snow could also be swept effectively.

(3) Roofs were best decontaminated by sweeping with brooms. The use of fire hoses was of marginal effectiveness.

(4) A 3½-acre living quarters complex can be decontaminated 80% by a 24-man team which would receive less than a 5 r dose after a two-week waiting period under the fallout conditions of 2000 r/hr at H+1.

(5) Migration of fallout in ice and snow was restricted to a few inches vertically and a few feet horizontally under the weather conditions experienced at the site.

MILITARY APPLICATION

The available decontamination technical manuals, TM 3-220 and TM 3-225, are inadequate for planning radiological countermeasures under cold-weather conditions. This report covers the FY-62 effort to obtain information to correct this deficiency.

CONTENTS

COLD WEATHER DECONTAMINATION STUDY - MCCOY II

I. INTRODUCTION.

1.1 Objective.

The objective of this project was to conduct experiments and collate data pertinent to radiological decontamination under cold-weather conditions so that the necessary data would be available for publication of a cold-weather addendum to the Departments of the Army and Navy technical manual TM 3-225 (NAVDOCKS TP-PL-13), Radiological Recovery of Fixed Military Installations.[1]

1.2 Justification and Requirements.

TM 3-225 presents methods and data necessary to perform decontamination operations on fixed military installations under temperate-weather conditions. The application of basic recovery criteria contained in this manual will have to be modified, or alternate methods employed, for decontamination operations under cold-weather conditions. Large portions of the United States could be affected for an extended period of time by cold weather (-10° to +32°F), thus affecting any contemplated decontamination operation.

1.3 Background.

The historical background and cold-weather data background pertinent to this project are contained in the first report of this project, NDL-TR-24, "Cold Weather Decontamination Study - McCoy I."[2]

1.4 Operational Plans.

The following testing schedule was planned at the Camp McCoy test site (see figure I-1) in the temperature range from -10°F to +32°F.

1.4.1 A series of 42 decontamination trials, using radioactive fallout simulant on nominal 20- by 100-ft areas to obtain effectiveness and effort data.

1.4.2 The decontamination of a 4-acre complex of buildings and of surrounding terrain and pavement, contaminated with radioactive fallout simulant, to obtain logistic requirements for an integrated recovery effort.

1.4.3 A series of tests, tracing the movement of fluorescent fallout simulant that had been deposited on snow in order to obtain data on vertical and horizontal migration.

1.4.4 Two tests to determine the shielding effects of snow and ice cover over fallout.

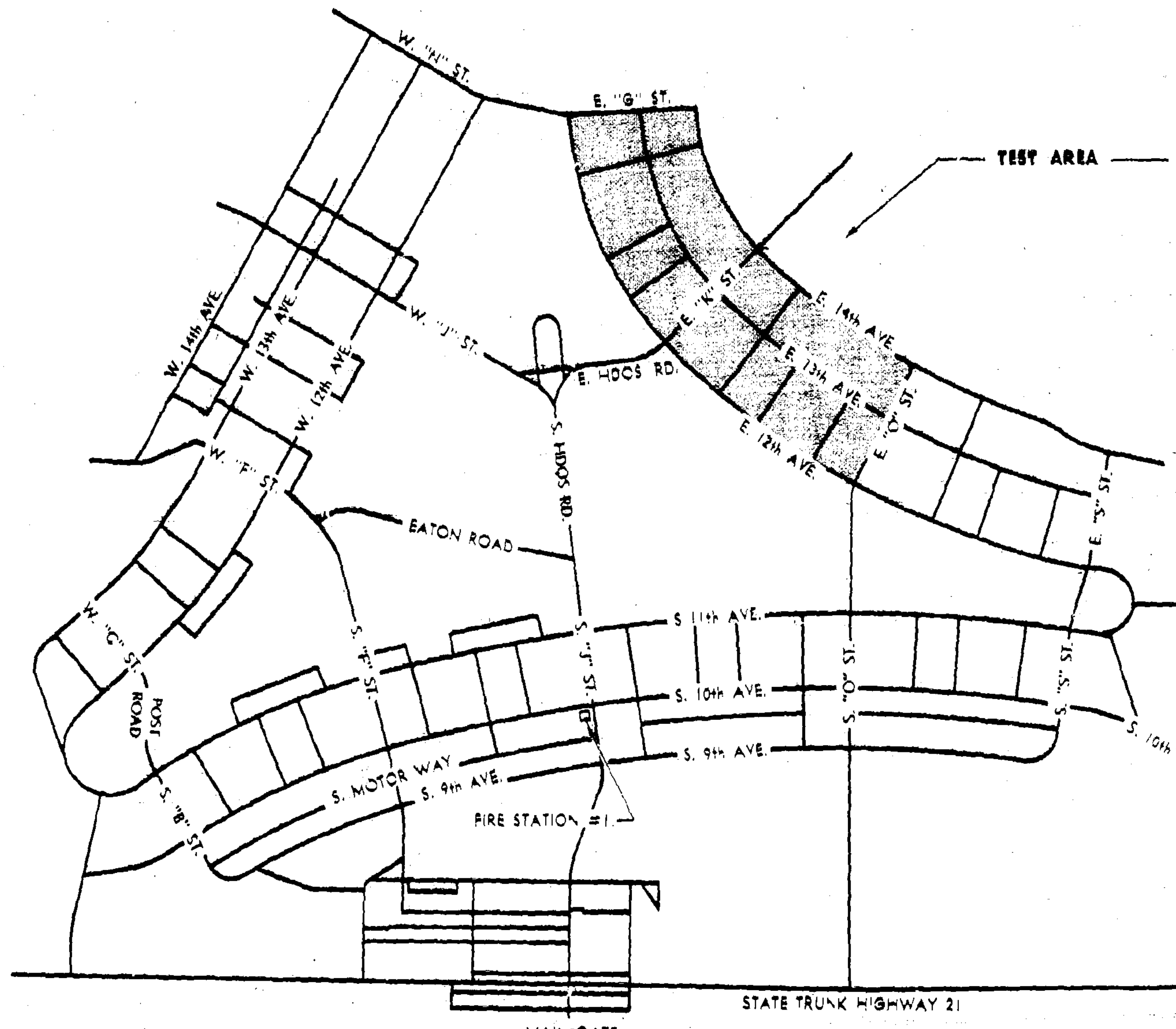


FIGURE I-1 GENERAL LAYOUT OF

TABLE II-2

DESCRIPTION OF EQUIPMENT USED DURING TEST-PLOT DECONTAMINATION EXERCISES

Equipment	Description	Serial and/or Model Number	Manufacturer
Mechanical Sweeper	Elgin Street King	MDL Street King, S/N 1457	Elgin Sweeper Co., Elgin, Illinois
Vacuum Sweeper	Tennant	MDL 100, S/N 200	G. H. Tennant Co., Minneapolis, Minn.
Motor Grader	Grader, Road; DED, 4x4; 76 hp diesel	MDL 99-H S/N H-5978	Austin-Western Co., Aurora, Illinois
Fire Hose	$1\frac{1}{2}$-in. fog nozzle $1\frac{1}{2}$-in. nozzle $2\frac{1}{2}$-in. nozzle	P-P Quad-way $\frac{3}{4}$-in. straight bore 1-in. straight bore	Wooster Brass Co., Dayton, Ohio
Blade Snow Plow	Plow, snow; straight blade with wing; truck-mounted	MDL Ross-R-2-22	The Burch Co., Minneapolis, Minn.
Rotary Snow Plow	Plow, snow; rotary; GED; truck-mounted	MDL 37-PR-188	William Bros. Boiler & Mfg. Minneapolis, Minn.
Rotary Broom Sweeper	Sweeper, rotary; one-way mounted on Tractor, wheeled agriculture	Sweepster MDL B, S/N 126578	Jenkins Equipment Co., Dexter, Michigan Allis Chalmers, Milwaukee, Wisconsin
Towed Scraper (Pan Loader)	Scraper, road-towed type; 8 cu yd	MDL DC-9 S/N 11065	The Heil Co., Milwaukee, Wisconsin
	Tractor, full-tracked low-speed, with straight push blade (Caterpillar No. 8-5)	MDL D-8 S/N 2N19602	Caterpillar Tractor Co., Peoria, Illinois

(3) adding a 19% solution of sodium silicate to serve as a binder; (4) baking the mixture at 1000°C for one hour to fuse the sodium silicate; and (5) blending the radioactive sand with cold sand to provide a fallout simulant with the level of specific activity desired for a particular test. This latter operation was completed just prior to the start of a test series. Detailed descriptions of the equipment and processes used in fallout-simulant production are presented in Appendix A.

2.1.3 Simulant Dispersal.

The fallout simulant was dispersed on land-surface areas by a Burch-Hydron sand spreader mounted on a 1½-ton dump truck (see figure II-1). At the start of a test series, the fallout simulant was transferred from the blending truck to the spreader by means of a fork-lift-mounted hopper. The spreader, adjusted to deliver ~ 50 grams of simulant per square foot in a swath eight feet wide, was then driven over the test area at slow speed to minimize slippage of the friction-drive wheels. On roof surfaces, the fallout simulant was spread with a two-foot-wide Scott lawn spreader equipped with a ten-foot-long extension handle.

2.2 Preparation of Test Surfaces.

Decontamination operations were conducted on seven types of surfaces during this series of tests:

1. Bare ground (frozen)
2. Bare asphalt
3. Bare concrete
4. Packed snow
5. Loose snow over packed snow
6. Undisturbed snow
7. Bare asphalt-shingle roofs

The bare-ground, bare-asphalt, and the snow test plots measured 20 x 100 feet, while the bare-concrete plots measured 20 x 60 feet and the roof areas varied from 600 to 2000 square feet.

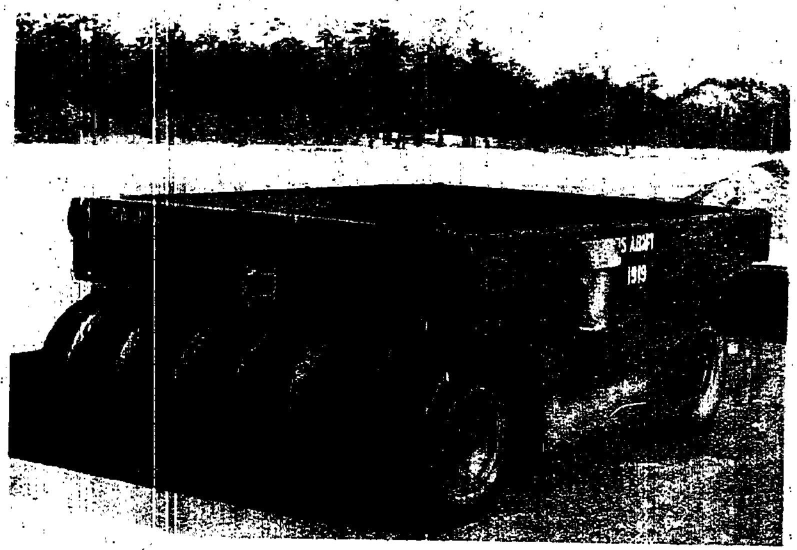
Since the Camp McCoy test site was covered with an average of seven inches of snow throughout the test period, preparation of bare-surface test plots involved the movement of large amounts of snow. Land-surface areas were cleared by means of road graders followed by mechanized sweepers (see figures II-2a,b). Roof areas were cleared by hand-shoveling and sweeping.

A tractor-towed pneumatic roller (see figure II-2c) was used to prepare the packed-snow plots. Since no significant snowfall occurred during most of the test period, one area requiring loose snow over packed snow was prepared by picking up loose snow with a tractor-mounted front-loader (see figure II-2d), and dumping and levelling it over packed snow.

FIGURE II-1 BURCH-HYDRON SAND SPREADER

(a) Motor Grader

(b) Mechanized Sweeper



(c) Pneumatic Roller

(d) Front Loader

NPC 16,594

FIGURE II-2 EQUIPMENT USED TO PREPARE TEST PLOTS

2.3 Decontamination Operations.

The various types of equipment employed in decontaminating test plots are shown in figure II-3. All units tested were of the type normally available at large military installations. Except for the rotary snow plow (blower) and the towed scraper (pan loader), which were tested under loose-snow conditions only, all units were operated under a variety of surface and temperature conditions.

2.3.1 Mechanized Equipment Operation.

Removal of fallout simulant was accomplished by covering the test-plot area once with the particular vehicle being tested, with the exception of the motor grader tests, one vacuum sweeper test, and one mechanical sweeper test. The sweeper tests are so indicated by first and second decontamination.* All grading of snow-covered test plots was done in two successive cuts,** although only one test reports the intermediate decontamination percentages. All vehicles, except the sweepers, made passes† from the same direction, each pass slightly overlapping the previous one. The sweeper made back-and-forth passes. All equipment was adjusted to achieve the maximum effectiveness possible in one decontamination. The windrows created by grading and rotary broom sweeping of snow were pushed in one direction to a distance of ten feet from the edge of the test plot. The snow collected by the sweeper and towed scraper was dumped in a centrally located area.

2.3.2 Mechanized Equipment Decontamination.

Under the dry, cold conditions encountered during this series of tests, little difficulty was experienced in removing radioactivity that had accumulated on mechanized equipment during decontamination operations. The material did not adhere to rubber or steel surfaces, so that it was readily removed by brushing. Equipment with contaminated grease and oil spots was effectively decontaminated by steam when applied under the shelter of a building. In cases of low activity, hot spots were allowed to decay. Material accumulating on grease and oil spots amounted to a small fraction of the total activity found on equipment after completion of operations.

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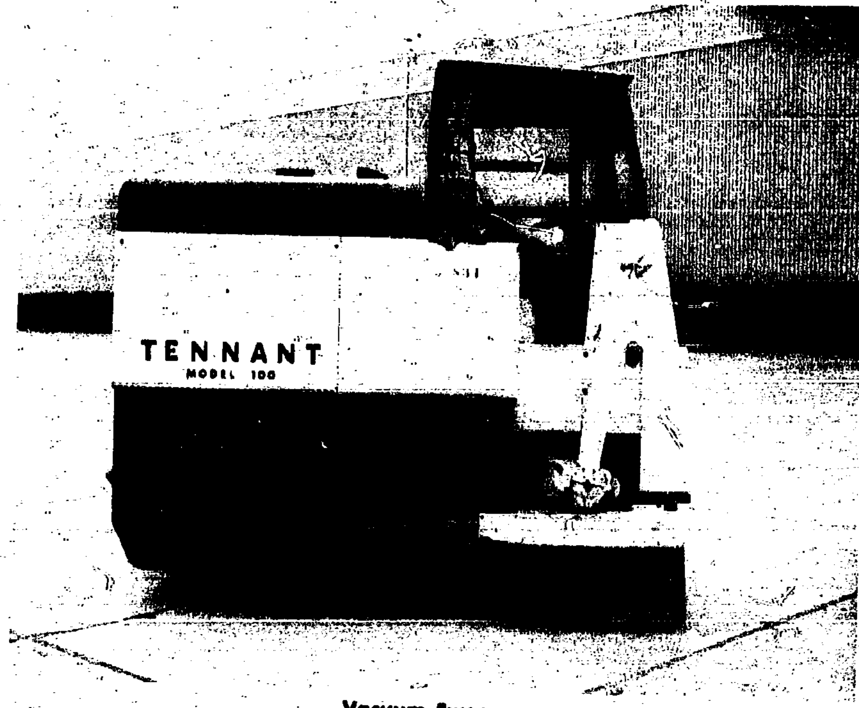
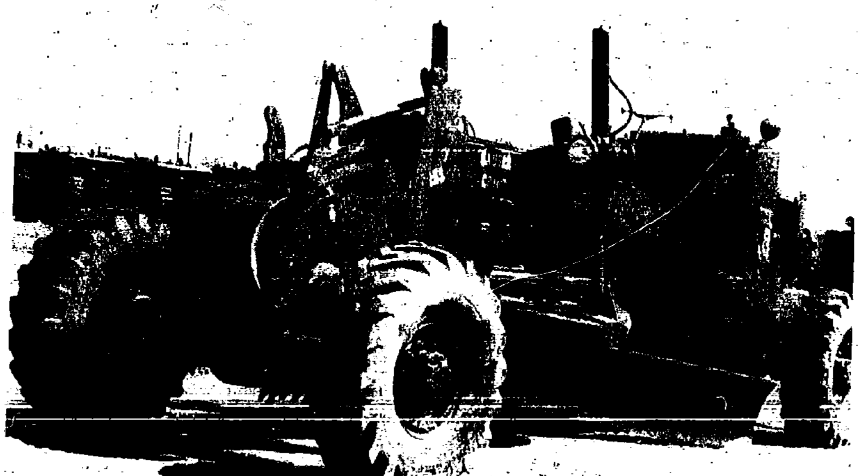
* The test plot was not recontaminated between first and second decontaminations.

** Cut refers to the removal of a top layer of snow from the entire test plot.

† Pass means one trip across the length of the test plot.

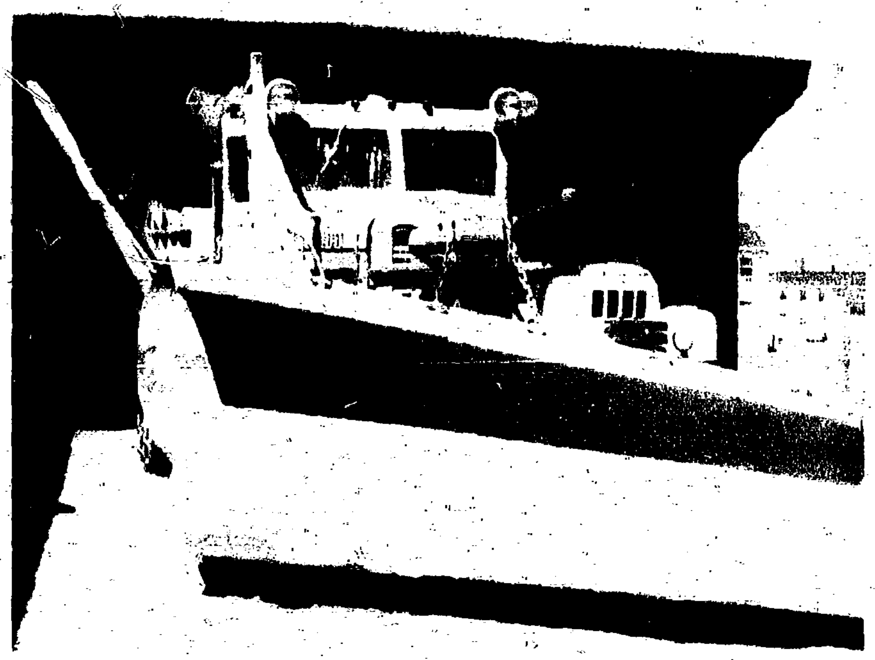


Vacuum Sweeper

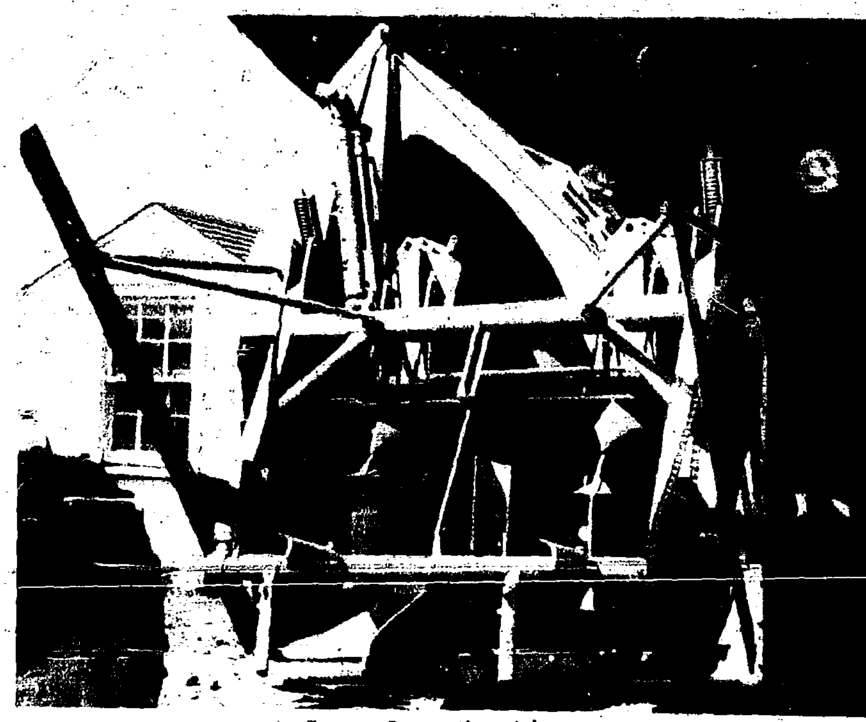


Motor Grader

FIGURE II-3 TEST-PLOT DECONTAMINATION EQUIPMENT

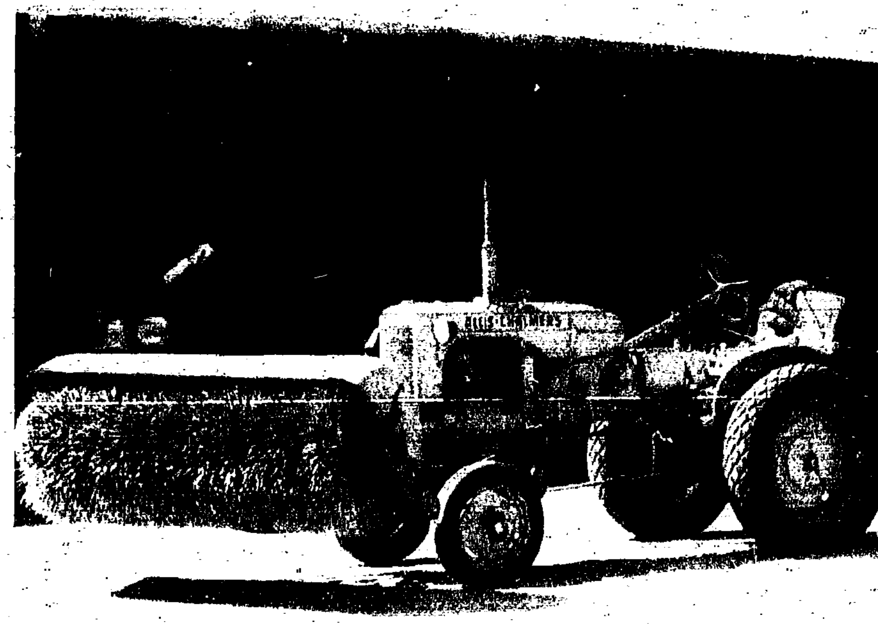


Blade Snow Plow

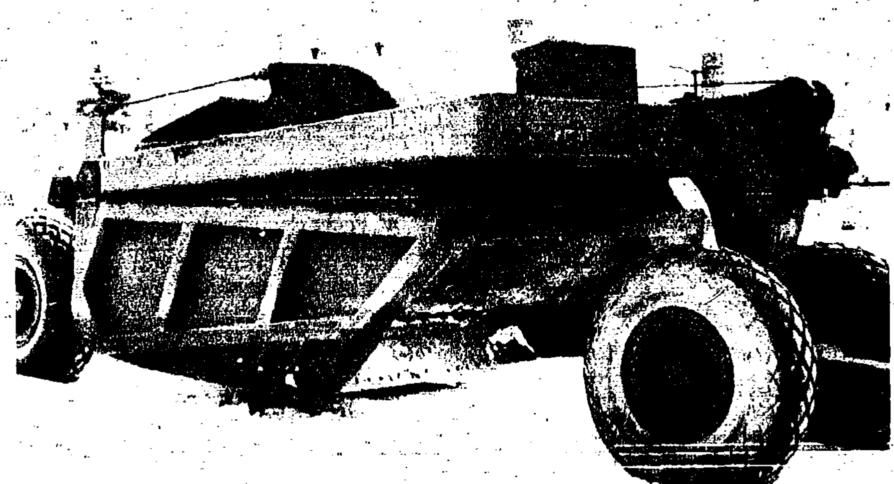


Rotary Snow Plow (Blower)

FIGURE II-3 (CONT'D)



Rotary Broom Sweeper



Towed Scraper (Pan Loader)

FIGURE II-3 (CONT'D)

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FIGURE II-4 FIRE-HOSING OPERATIONS

2.3.3 Fire Hose Operation.

Except for one test (bare ground at 21°F, fog nozzle) in which a fire-engine pumper was used to boost pressure, all fire-hosing operations were conducted at local hydrant pressures of approximately 90 psig. This resulted in nozzle pressures of 40-50 psi, depending on the size and type of nozzle used and the length of hose lay. Three types of nozzles were used, all manufactured by the Wooster Brass Company: a $2\frac{1}{2}$-inch nozzle with a 1-inch bore; a $1\frac{1}{2}$-inch nozzle with a $\frac{5}{8}$-inch bore; and a $1\frac{1}{2}$-inch nozzle with PP quad-way adjustable bore. The first two were regular straight-bore hose nozzles, while the latter was an adjustable-bore fog nozzle. Standard $2\frac{1}{2}$-inch-diameter fire hose was used except with the $1\frac{1}{2}$-inch nozzles where several lengths of $1\frac{1}{2}$-inch diameter hose were used between the nozzle and the supply line.

Roofs were decontaminated by lobbing the water from ground level; surface plots were cleaned by walking over the plots and directing the stream forward and to the sides so that the simulate was washed to the sides of the plots. Hosing operations were terminated when, on the basis of visual observations, material removal was essentially complete or freezing conditions rendered further effort ineffective. Typical hosing operations are shown in figure II-4.

2.4 Test Measurements.

Test measurements included radioactivity levels, meteorological conditions, and time required to complete decontamination operations.

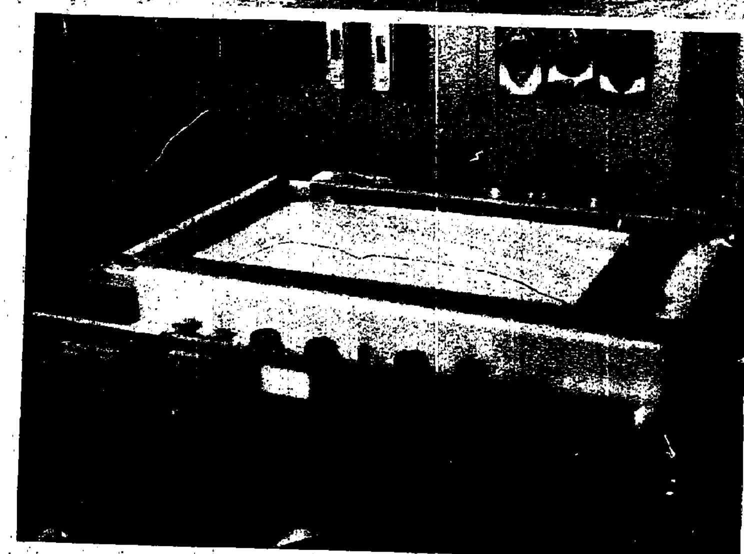
2.4.1 Radioactivity.

A variety of different types of radioactivity measurements were required in this test program. These included (1) source strength of the tracer material, (2) concentrations of radioactivity in the fallout simulant, (3) radioactivity on test plots before and after decontamination, (4) doses received by equipment operators, and (5) the many routine health-physics type measurements required to support large-scale field tests involving the use of radioactivity. Radiation measurements made during simulant production are discussed in Appendix A. Radiation measurements made as part of the health-physics support program are presented in Appendix B.

Radiation levels on land-surface test plots, before and after decontamination operations, were measured with a continuous-scanning radiation-detection system (see figure II-5). This system, which is described in detail in Appendix C, consists of a collimated anthracene scintillation detector, a 20-foot horizontal traversing mechanism, and an X-Y recorder. Operated at a height of one foot, the detector has an unshielded circle of acceptance on the test surface of one foot in diameter. In taking the measurements, continuous traverses were made at ten-foot intervals along the length of the test plots.

Moving The Detection System

Scanning A Plot



X-Y Recorder

FIGURE II-5 CONTINUOUS-SCANNING RADIATION-DETECTION SYSTEM

Radiation levels on roofs of buildings and dose rates at vehicle operator positions were measured with an Eberline Model E-200 radiation survey meter or a Nuclear-Chicago Model 2586 "Cutie-Pie" radiation-detector meter.

2.4.2 Meteorological Conditions.

Four types of meteorological measurements were made during test operations: (1) surface temperature, (2) air temperature, (3) wind speed, and (4) snow density. Surface temperatures were measured with thermometers placed face-up on the test plot; air temperatures were measured with thermometers mounted on the radiation-detection traversing mechanism at a height of 3 feet. Wind speed measurements were made with an anemometer mounted on top of Building 645. Snow density was determined by weighing a sample in a plastic cylinder graduated in volume units. Further details regarding meteorological measurements are presented in Appendix D.

2.4.3 Decontamination Time.

The time required by a particular vehicle to decontaminate a given type of surface area was measured with a stop watch. Timing of decontamination operations began when a vehicle started its first pass over a test plot and ended when the vehicle had covered the plot. Off-plot maneuvering of the vehicle was not included in the timing of the operation.

2.4.4 Field Data.

The following data were recorded during each decontamination test:

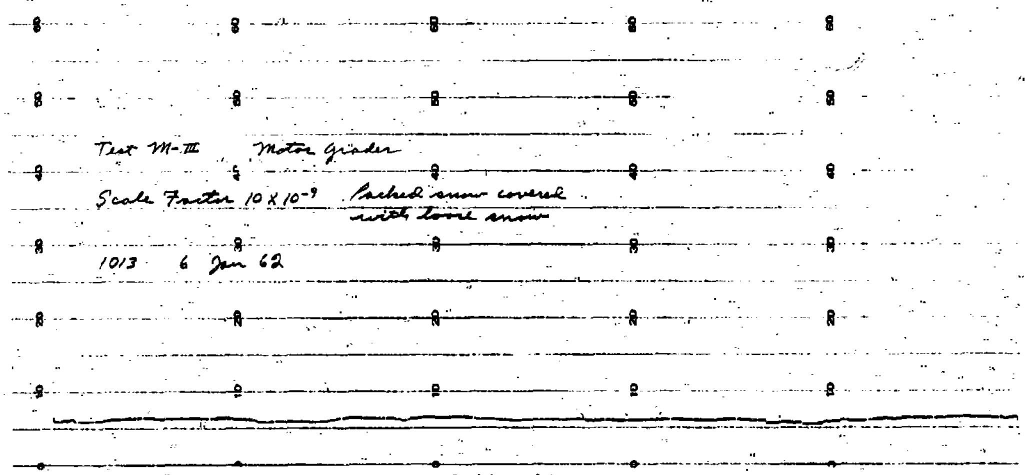
Background radiation levels across the center of the plot at several different instrument sensitivities.

Radiation levels at 10-ft intervals across the contaminated and decontaminated plot.

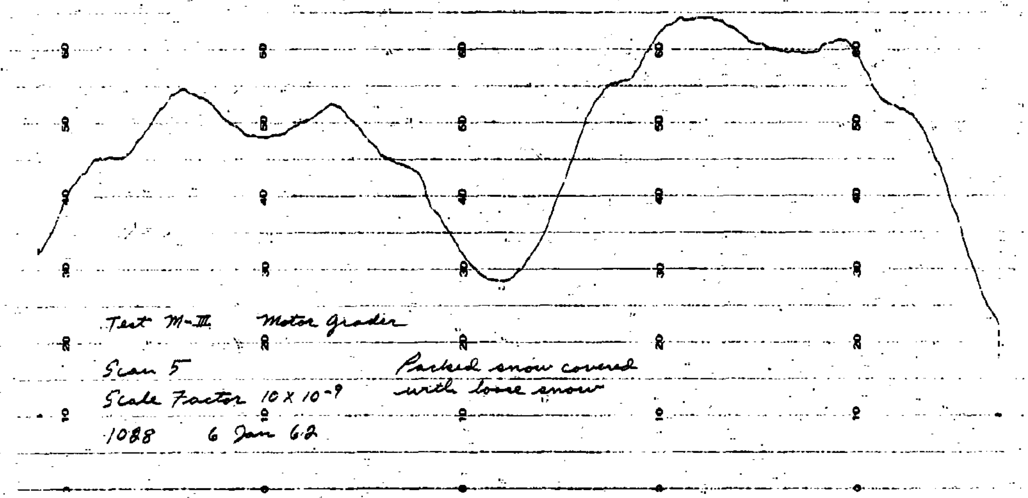
Dose rate to the decontamination operator both on and off test plot.

Time for each decontamination pass.

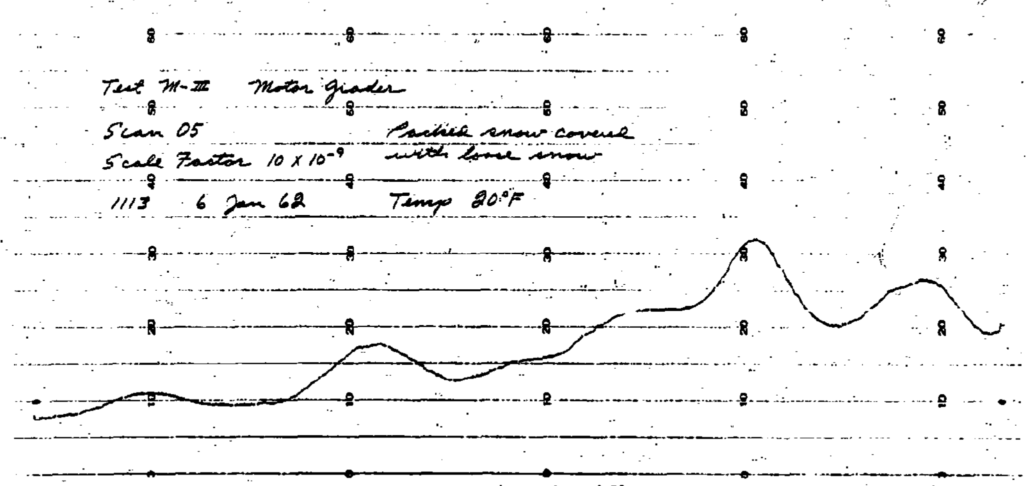
Typical x-y curves recorded from each scan are shown in figure II-6. The areas under each curve, including the radiation background curves, were obtained with a planimeter. After subtracting the appropriate background-data area from each scan, the net area was entered on the data sheets shown in Appendix E. The ratio of the decontamination area to the contamination area gives the fraction of material left on the plot;



Background Scan



Scan Of Contaminated Plot



Scan Of Decontaminated Plot

FIGURE II-6 TYPICAL X-Y RECORDINGS OF SCAN INFORMATION

the remaining fraction is, of course, the amount removed. The remaining fraction is shown as percentage of decontamination in all data sheets and summaries. It was not necessary to convert any scanner data to radiation intensities, since only the removal efficiency of each technique was desired. However, the values reported as radiation levels are approximately 6.67 mr/hr at the detector element per unit area.

2.5 Results and Discussion.

2.5.1 Results.

The data collected from the field tests of decontamination of test plots are summarized in table II-3. This summary of results includes the average percentage of decontamination and its 90% confidence interval, the air and surface temperature, the average activity level on the surface prior to decontamination, work rate, and the operator dose rate. Detailed data are given in Appendix E.

Based on statistical analyses of the field data, the following results from the tests were obtained:

There is no significant effect of temperature on the effectiveness of sweeping bare, frozen ground. Decontamination of 86% to 90% can be expected from mechanical or vacuum sweeping of bare frozen ground under normal conditions and properly operating equipment at a rate of about 600 square feet per minute. Decontamination of bare frozen ground by fire hosing results in less than 50% decontamination. If the ground is reasonably sloped, short distances may be decontaminated by fire hosing with a maximum of about 85% and a decrease of approximately 0.4% per linear foot of progress.* Without a good runoff of water, freezing will occur and effectiveness will be less than 20%. Using two 1½-inch hoses, decontamination rate is about 250 square foot per minute. Decontamination of frozen ground by bulldozing and grading is completely ineffective.

Decontamination of bare concrete or asphalt surfaces at subfreezing temperatures by mechanical sweeping will result in 92% to 95% decontamination at a rate of about 1100 square feet per minute, and is not significantly different from test results at above freezing temperatures. Fire hosing of concrete and asphalt is very effective at temperatures near 0°F, again, provided there is reasonable slope of surface to facilitate water runoff. Fire hosing of concrete and asphalt will result in a maximum of 96% decontamination with about 0.1% decrease per linear foot of progress at a rate of 250 square feet per minute using two 1½-inch hoses.

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* Linear foot of progress means the distance traveled by the decontamination apparatus from the point or line that the decontamination was started.

TABLE II-3

SUMMARY OF TEST-PLOT DATA

Type of Surface	Type of Equipment and Date	Temperature Air	Temperature Surface	Average Dose Rate to Operator	Man-Hours per 1000 ft^2	Activity Level	Decon-tamination	Comments
		(°F)	(°F)	mr/hr		mc/ft^2	%	
Bare Ground	Mechanical Sweeper							
	10 Jan 62	-6	-4	27	0.022	0.29	86.0 ±7.8	
	23 Jan 62	22	20	40	0.013	0.68	90.4 ±2.1	
	5 Jan 62	26	27	50	0.045	0.49	86.6 ±1.7	
	Vacuum Sweeper							
	17 Jan 62	-15	-14	40	0.013	0.89	88.0 ±0.9	
	30 Dec 61	18	18	19	0.033	0.26	37.1 ±6.4	Sweeper broke before decon. Effectiveness of repairs questionable
	5 Jan 62	26	27	15	0.033	0.46	70.0 ±3.1	
	Motor Grader							
	10 Jan 62	-3	-1	15	0.083	0.29	10.8 ±15.0	Ground frozen too hard for blade to penetrate
	Fire Hose							
	20 Jan 62	0	-1	12	0.242	0.36	50.2 ±12.8	$2\frac{1}{2}$-in. nozzle, 1-in. bore
	19 Jan 62	4	10	15	0.300	0.54	55.3 ±11.4	$2\frac{1}{2}$-in. nozzle, 1-in. bore Ground frozen to depth of three feet
	6 Jan 62	20	21	20	0.083	0.62	15.1 ±7.0	$1\frac{1}{2}$-in. PP Quad-way nozzle
	Rotary Broom Sweeper							
	24 Jan 62	34	33	40	0.011	0.54	65.6 ±11.3	

TABLE II-3

SUMMARY OF TEST-PLOT DATA (CONTD.)

Type of Surface	Type of Equipment and Date	Temperature Air	Temperature Surface	Average Dose Rate to Operator	Man-Hours per 1000 ft²	Activity Level	Decon-tamination	Comments
		(°F)	(°F)	mr/hr		mc/ft²	%	
Bare Asphalt	Mechanical Sweeper							
	9 Jan 62	-11	-8	15	0.015	0.23	94.3 ±0.9	
	30 Dec 61	7	8	11	0.021	0.18	73.4 ±1.0	Sweeper malfunctioned third pass
	Fire Hose							
	17 Jan 62	0	-4	30	0.350	0.83	93.0 ±1.6	
Bare Concrete	Mechanical Sweeper							
	9 Jan 62	-7	-3	12	0.010	0.22	93.5 ±1.6	
	Vacuum Sweeper							
	30 Dec 61	18	16	23	0.056	0.25	81.9 ±10.9	First decon
	30 Dec 61	18	16		0.125		86.6 ± 3.9	Second decon. Work rate includes total time for both decontaminations
	Fire Hose							
	19 Jan 62	-1	0	6	0.556	0.33	42.9 ±41.0	$2\frac{1}{2}$-in nozzle 1-in bore. Poor drainage
	20 Jan 62	2	3	6	0.194	0.40	93.3 ±2.7	$2\frac{1}{2}$-in nozzle 1-in bore. Good drainage

TABLE II-3

SUMMARY OF TEST-PLOT DATA (CONTD.)

Type of Surface	Type of Equipment and Date	Temperature Air	Temperature Surface	Average Dose Rate to Operator	Man-Hours per 1000 ft²	Activity Level	Decon-tamination	Comments
		(°F)	(°F)	mr/hr		mc/ft²	%	
Packed Snow	**Mechanical Sweeper**							
	9 Jan 62	-6	-4	35	0.011	0.21	93.4 ±2.1	
	23 Jan 62	24	20	25	0.017	0.49	94.2 ±0.8	High winds blowing sand off plot
	5 Jan 62	24	26	22	0.017	0.56	49.3 ±8.2	1st decon.
	5 Jan 62	24	26		0.033		85.1 ±4.0	2nd decon. Work rate includes total time for both decons. Hopper cleaned and brushes adjusted after this test
	Vacuum Sweeper							
	9 Jan 62	-7	-8	20	0.025	0.27	53.8 ±2.2	
	29 Dec 61	6	11	19	0.029	0.51	84.0 ±2.7	
	5 Jan 62	26	28	15	0.038	0.50	86.6 ±2.3	
	Motor Grading							
	9 Jan 62	-8	-10	20	0.014	0.25	86.2 ±7.9	Two cuts
	29 Dec 61	9	14	20	0.018	0.44	78.8 ±6.2	1st cut-Operator's first try on this type test plot
	29 Dec 61	9	14	5	0.036		83.6 ±5.4	2nd cut-Work rate includes total time for both decons.
	5 Jan 62	26	26	10	0.067	No data	91.6 ±1.4	Two cuts
	Fire Hose							
	20 Jan 62	-1	-6	6	0.500	0.52	76.3 ±5.4	$2\frac{1}{2}$-in.nozzle,1-in.bore
	24 Jan 62	20	18	7	0.300	0.69	81.5 ±1.9	$2\frac{1}{2}$-in.nozzle,1-in.bore
	24 Jan 62	33	28	8	0.417	0.44	88.9 ±3.0	$2\frac{1}{2}$-in.nozzle,1-in.bore
	Rotary Broom Sweeper							
	25 Jan 62	37	32	50	0.010	0.46	79.8 ±7.8	Snow near melting. Windrow tended to stall sweeper after 3rd pass

TABLE II-3

SUMMARY OF TEST-PLOT DATA (CONTD.)

Type of Surface	Type of Equipment and Date	Temperature Air	Temperature Surface	Average Dose Rate to Operator	Man-Hours per 1000 ft^2	Activity Level	Decon-tamination	Comments
		(°F)	(°F)	mr/hr		mc/ft^2	%	
Loose over Packed Snow	Motor Grader							
	18 Jan 62	-1	-5	10	0.028	0.49	89.5 ±2.4	Decon followed efforts of blade snow plow
	6 Jan 62	18	20	30	0.050	0.68	62.8 ±5.3	Operator's first try on this type test plot
	Blade Snow Plow							
	18 Jan 62	-2	-1	10	0.004	0.49	15.9 ±7.8	Surface frozen too hard for blade to penetrate
Undisturbed Snow	Motor Grader							
	10 Jan 62	1	0	7	0.015	0.29	64.2 ±2.3	Two cuts
	30 Dec 61	18	19	8	0.042	0.41	54.0 ±2.6	Operator's first try on this type test plot. Two cuts
	Blade Snow Plow							
	18 Jan 62	2	0	12	0.003	0.52	95.4 ±0.6	Highly exper. operator
	Rotary Snow Plow							
	18 Jan 62	-1	-2	13	0.018	0.48	82.9 ±2.0	Caused extensive contam. of surrounding area
	Towed Scraper							
	25 Jan 62	29	24	12	0.014	0.51	86.5 ±4.6	

TABLE II-3

SUMMARY OF TEST-PLOT DATA (CONTD.)

Type of Surface	Type of Equipment and Date	Temperature Air	Temperature Surface	Average Dose Rate to Operator	Man-Hours per 1000 ft^2	Activity Level	Decon-tamination	Comments
		(°F)	(°F)	mr/hr		mc/ft^2	%	
Bare Roof	**Fire Hose**							
	17 Jan 62	-7	-4	2	0.467	No data	42.0 ±7.4	$1\frac{1}{2}$-in. nozzle $\frac{3}{4}$-in. bore
	6 Feb 62	2	14	5	0.100	No data	65.3 ±15.0	$2\frac{1}{2}$-in. nozzle 1-in. bore Heated building
	6 Jan 62	21	24	5	0.860	No data	68.5 ±22.9	$1\frac{1}{2}$-in. PP Quad-way nozzle
	Hand Broom							
	1 Feb 62	13	No data	20	0.99	No data	82.4 ±6.4	Bldgs 505 & 506 in Logistics Exercise
	2 Feb 62	26	No data	10	1.27	No data	81.8 ±6.6	Bldgs 516 & 517 in Logistics Exercise

Packed snow can be decontaminated by mechanical sweeping with an effectiveness from 90% to 95% at a rate of 1,000 square feet per minute at temperatures below 22°F. Vacuum sweeping of packed snow results in 80% to 90% decontamination between temperatures of 10°F and 30°F at a rate of 500 square feet per minute. Sub-zero temperatures reduce vacuum sweeping of packed snow to approximately 50% decontamination. Fire hosing of packed snow is a feasible method provided all the snow can be washed away in the process. Test data indicate that the decontamination effectiveness is temperature dependent. At 30°F, fire hosing of packed snow will result in a maximum of 95% decontamination with a decrease of 0.1% per linear foot of progress. At lower temperatures, the maximum percentage will decrease by 0.5% per degree. The fire hosing rate with two $1\frac{1}{2}$-in. hoses will be approximately 150 square feet per minute. Motor grading of packed snow gives a maximum of 97% decontamination with a decrease of 0.2% per linear foot of progress after two cuts over the area. The linear factor is temperature dependent; it doubles for subzero temperatures and is about half for near freezing temperatures. Decontamination is increased approximately 5% by the second cut. The time required for grading packed snow with two cuts is about 300 square feet per minute, but this does not include windrow removal. Blade snow plowing of packed snow is ineffective.

Undisturbed snow decontaminated at temperatures near zero by blade snow plowing results in 94% to 97% decontamination at a rate of 5,000 square feet per minute with little or no decrease per linear foot of progress; however, there is a decrease of about 0.4% per foot perpendicular* to the vehicle's motion in the direction the snow is thrown. Rotary snow plowing at 0°F gives a maximum of 90% decontamination with a decrease of about 0.1% per linear foot of progress and a rate of 900 square foot per minute. Motor grading of loose snow gives 55% to 65% decontamination with little linear decrease at a rate of about 500 square feet per minute. Decontamination of loose snow with a towed scraper gives a maximum of 96% and a decrease of 0.2% per foot of progress at a rate of 1200 square feet per minute. This rate cannot be maintained as dumping will be required for each 1,000 to 2,000 square feet of snow decontaminated.

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* Decrease in decontamination effectiveness perpendicular to the vehicle's motion means that subsequent passes made by the plow to widen the decontaminated area became less effective.

Bare, sloped, asphalt-shingled roofs can be decontaminated by hand broom sweeping by 76% to 88% and is temperature independent. Fire hosing of bare roofs from the ground gives approximately 45% decontamination at near zero temperatures and approximately 67% decontamination at about 25°F. For a heated building, the roof decontamination from fire hosing will be about 65% at near zero temperatures.

2.5.2 Discussion.

The results derived from the decontamination of test plots could not be based solely on the decontamination percentages calculated from the radiation intensity measurements. Operational variables, such as operator inexperience, mechanical difficulties, and condition of surface, had indeterminable adverse effects on the results. In most of the entire series of test these operational variables completely disguised any possible temperature dependence of decontamination methods. Repetition of tests is a prerequisite of rigorous statistical analyses, which enables the elimination of experimental error from the results. Without repeated testing under identical conditions, as in this series, there is a great dependience upon observations taken during the experiments. These observations provide explanation for seemingly illogical data.

Each individual test was analyzed for the percentage of decontamination and, where applicable, for variations of decontamination with travel progress. These tests were then grouped by test surface and method for comparison with one another. A brief discussion of each of the test groups follows:

Bare Frozen Ground.

Bare frozen ground can best be decontaminated by mechanical sweeping. Of the methods tested, mechanical sweeping gave the most consistent high effectiveness and the lowest work rates. The results showed no temperature dependence, nor was it expected. It is of interest to note that the highest effectiveness corresponds to the lowest work rate. Due to the back-and-forth passes over the test plot, no analyses is possible for linear progress effect on decontamination.

The vacuum sweeper is comparable to the mechanical sweeper in decontamination of bare frozen ground. The poor results encountered in two of the three tests can be contributed to faulty equipment; if in proper repair, decontamination from 85% to 90% should be expected.

Grading on bare frozen ground is almost completely ineffective. The scraper blade will not penetrate the ground and succeeds only in rearranging the material. After obtaining the decontamination data from the grader operation, the D-8 bulldozer was tried on the same test plot. Even by dropping the blade from a height of two feet, it was impossible to dent the surface of the ground. At this time, it was estimated that the ground was frozen to a depth of two to three feet.

Fire hosing of frozen ground cannot result in more than approximately 80% decontamination at subfreezing temperatures. Sand particles are trapped by irregularities in the surface and become frozen in the accumulated ice. This becomes more pronounced as an area is extended. Effectiveness will decrease from 0.2 to 0.7 percent per foot of progress, depending upon the temperature and slope of the land. Effectiveness also tends to be dependent upon the work rate.

Asphalt and Concrete.

There was no apparent difference between bare concrete decontamination by sweeping or hosing. The decontamination of smooth hard surfaces with a mechanical sweeper will be from 92% to 95% under cold weather conditions, which is the same as reported by U. S. Naval Radiological Defense Laboratory (USNRDL)[3] for temperate weather tests. The low percentages obtained from one mechanical sweeper test on asphalt and from the vacuum sweeper test on concrete were due to faulty equipment. With proper drainage 90% to 96% decontamination can be obtained from fire hosing at near zero temperatures, as compared to 95% to 98% expected under temperate weather conditions.[4] Without drainage of water, very poor decontamination results from fire hosing.

Packed Snow.

Packed snow may be decontaminated by sweeping the fallout from the surface or by removal of the snow by grading or fire hosing. Mechanical sweeping is the most effective method, giving 90% to 95% decontamination with proper adjustment of the brush. Its limitation is its hopper capacity which necessitates frequent unloading when used over snow. The vacuum sweeper is not as good over packed snow for several reasons: the surface is relatively rough; the sweeper's traction is marginal; the hopper fills up very rapidly. With a properly operating vacuum sweeper, 80% to 90% decontamination can be expected for hard packed snow areas of less than 2000 square feet per hopper full.

Motor grading of packed snow for decontamination is a matter of removing the snow from the surface. Although the simulant is originally on top of the snow cover, it tends to work under the moldboard as the snow is being scraped, thus reducing the effectiveness as progress is made. This reduction becomes more prominent as temperature decreases, which is probably due to the sand and ice crystals tending to have similar physical characteristics at near zero temperatures. When it is possible to remove all the packed snow with two cuts of 2 to 4 inches each, 97% decontamination can be expected at the beginning, with a reduction in effectiveness from 0.1% to 0.4% per foot of progress. Not enough data was obtained to indicate whether the reduction in decontamination with travel is a linear function or whether it will reach an equilibrium value.

Fire hosing of packed snow is an effective method, provided the snow can be washed from the surface in the process. Decontamination effectiveness increases as the temperature approaches thawing because the snow is easier to remove and because there is less likelihood of the water refreezing on the surface. The reduction of effectiveness with progress was detected from the fire hosing test data, the reduction being approximately 0.1% per foot; it would probably be higher if wider strips were washed.

Loose Snow Over Packed Snow.

There were two loose-snow-over-packed-snow tests. One plot consisted of light natural snowfall over a packed snow area. This plot was motor graded to produce results similar to grading of loose snow, except there was noted a reduction in effectiveness of about 0.1% per foot. The second plot was prepared by spreading loose snow over packed snow with a front-end loader. The following day the "loose" snow was frozen hard. As a result, the blade snow plow could not penetrate the snow. A motor grader was then used to decontaminate this area. The results from this test, as expected, were the same as those from packed snow tests.

Undisturbed Snow.

Undisturbed snow can be most effectively decontaminated from 94% to 97% by blade snow plowing and at a work rate unapproached by any other method employed in this series of tests. Although no reduction in effectiveness was detected along the path of progress, a reduction of 0.4% per foot was observed in the direction the snow was thrown.

Rotary snow plowing is much slower and less effective than that done with the blade. Decontamination of 90%, with a decrease of 0.1% per foot, may be expected for decontamination of about 6 inches of undisturbed snow. In the test, radiation levels as high as 5 mr/hr were measured out to 100 feet to the side of the test plot as simulant and snow were thrown into the air and carried downwind.

Motor grading of undisturbed snow gives from 55% to 65% decontamination. Operator skill will determine the effectiveness of decontamination within the above limits. As with packed snow, the simulant would work under the moldboard. In addition, with large amounts of snow being pushed aside, it was difficult to maintain the moldboard cutting edge parallel to the ground after the first pass, since one side of the machine was riding higher than the other. The angle of the moldboard was varied to prevent material from rolling over the top of the blade and back onto the cleared area.

The towed scraper results in faster, more thorough decontamination in about 6 inches of undisturbed snow than either the motor grader or rotary snow plow. The time rate is very deceptive as it does not include time for hauling and dumping, which would probably be necessary after every 1 to 2 minutes of scraping.

Bare Roofs.

Fire hosing of roofs in subfreezing weather results in almost immediate icing. The results show that the amount of decontamination is temperature dependent. It was also observed that a concentrated stream lobbed on the roof reduced icing rate over a spray or fog-type stream of water. The object was to get as large a volume of water as possible running down the roof in order to prevent freezing. The radiation measurements of the roof tests were extremely difficult to take. In one test, the decontaminated roof could not be measured for two days after the test because of icing. In another test, delay because of weather caused specific acitivity of the sand to decay to a very low level, and resulted in low radiation measurements. The resultant percentages of decontaminations are, therefore, not as accurate as those given for the test plots. They do serve, however, as a good indication of cold-weather decontamination that can be achieved by fire hosing.

Hand broom sweeping of roofs in cold weather gives results comparable to those from temperate weather tests.[5]

2.6 Conclusions.

1. In below-freezing weather, hard, dry surfaces can be decontaminated by 90% or more with mechanical or vacuum sweeping at a rate of 500 to 1000 square feet per minute (plus time required for emptying bins).

2. Fire hosing is 50% to 90% effective for decontamination of small areas in temperatures to zero, provided the surface is reasonably smooth and sloped, and the bulk snow or loose dirt to be moved is not too great. This method is slow; it requires three to five operators, and water flow must be maintained to prevent freezing in the hoses.

3. Packed snow may be 85% to 95% decontaminated by sweeping and 80% to 90% decontaminated by grading. Fire hosing of packed snow is possible under ideal conditions.

4. Undisturbed snow can be decontaminated only by removal of the snow. Possible methods, in order of their effectiveness, are blade snow plow, towed scraper, rotary snow plow, and grader.

5. Roofs can best be decontaminated by sweeping; fire hosing produced marginal results.

III. LOGISTICS EXERCISE

After completion of the evaluation tests described previously, a Logistics Exercise was conducted which had, as its objective, the determination of realistic equipment and manpower requirements for the decontamination of built-up areas composed of many surfaces. The area selected is shown in figure III-1, a plan view of a two-block section of Camp McCoy. This area, after being spread with fallout simulant, was decontaminated by two 12-man teams made up of troops from the Fifth Engineer Battalion, Fort Leonard Wood, Missouri, and from Mobile Construction Battalion Four, U. S. Navy, Davisville, Rhode Island.

The fallout simulant was prepared in the same manner as that used on the test plots (see Appendix A). A Burch-Hydron spreader (see figure II-1) was used wherever possible; roofs and other areas inaccessible to this vehicle were covered by means of hand tools and a garden spreader.

3.1 Description of Test Area.

The test area covers about 3½ acres of land on which are located four single-story frame buildings (505, 506, 516, and 517) and four two-story buildings (504, 507, 514, and 518), all having asphalt-shingle roofs. Ten-foot-square concrete slabs enclosed by low walls are located between some of the buildings and are used for storing coal. Bisecting the area is a macadam roadway, East L Street, on either side of which is a bar ditch. Where the access route indicated in the figure crosses the roadway, covered concrete culverts are located. At the time of the test, the whole area was covered by about six inches of frozen snow.

3.2 Test Operations.

The test area was divided into two main parts: Sector I, north of East L Street; and Sector II, south of East L Street. Each sector was then subdivided by the access route, the area east of the route being assigned to one team and that west of the route to the other. In this report, the teams will be referred to simply as Team A and Team B.

3.2.1 General Procedure.

The procedure adhered to in executing this exercise was, in general, as follows: GD/FW personnel spread the contaminant over Sector I and recorded measurements of the activity levels on the ground complex, on roofs, and inside the buildings. This group then proceeded to Sector II where they performed the same tasks. When the GD/FW group moved to Sector II, Teams A and B began their decontamination of Sector I. After the decontamination of Sector I, the GD/FW personnel returned to Sector I to take measurements of the residual activity while the two teams proceeded to decontaminate Sector II. When Sector II had been decontaminated, residual activity levels were also measured there.

The equipment used during the logistics exercise is described in Table III-1.

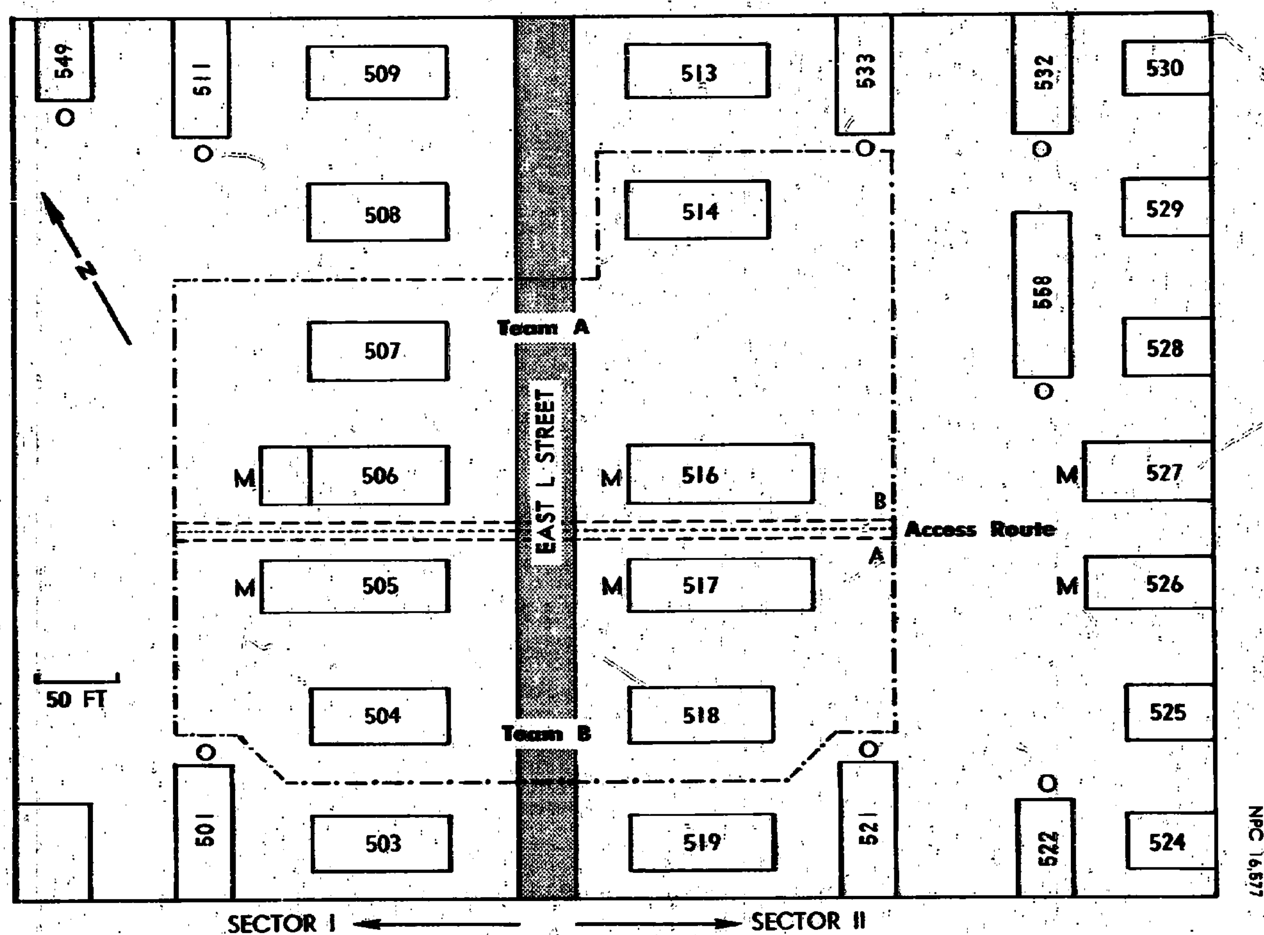

FIGURE III-1 LOGISTICS EXERCISE: PLAN VIEW OF TEST AREA

TABLE III-1

DESCRIPTION OF EQUIPMENT USED DURING LOGISTICS EXERCISE

Equipment	Description	Serial and/or Model Number	Manufacturer
Front Loader	Tractor, full-tracked; low-speed DED with front-end loader (D-4)	MDL 933	Caterpillar Tractor Co., Peoria, Illinois
Bulldozer	Tractor, full-tracked; low-speed with straight push blade (Caterpillar No. 8-S)	MDL D-8 S/N 2N19602	Caterpillar Tractor Co., Peoria, Illinois
Bulldozer	Tractor, full-tracked; low-speed with straight push blade (Caterpillar No 7A)	MDL D-7 S/N 3T17211	Caterpillar Tractor Co., Peoria, Illinois
Towed Scraper (Pan Loader)	Scraper, road-towed type; 8 cu. yd.	MDL OC-9 S/N 11065	The Heil Co., Milwaukee, Wisconsin
MRS Tractor	Tractor, diesel, wheeled type; 150 hp	MDL 150	MRS Tractor Co., Flora, Mississippi
Motor Grader	Grader, road; DED, 4x4; 76 hp diesel	MDL 99-H S/N H-5978	Austin Western Co. Aurora, Illinois
Motor Grader	Grader, road; DED, tandem drive	MDL 4D S/N MD 699	Huber Warco Co., Marion, Ohio
Spreader	Burch-Hydron Spreader (8') mounted on shielded dump truck	MDL HY60 S/N 96102	The Burch Corporation Crestline, Ohio
Rotary Broom Sweeper	Sweeper, rotary; one-way mounted on	Sweepster	Jenkins Equipment Co., Dexter, Michigan
	Tractor, wheeled, agriculture	MDL B S/N 126578	Allis Chalmers, Milwaukee, Wisconsin
Fire Hose	$1\frac{1}{2}$-inch nozzle	$\frac{3}{4}$-inch straight bore	Wooster Brass Co., Dayton, Ohio
	$2\frac{1}{2}$-inch nozzle	1-inch straight bore	

3.2.2 Decontamination of Sector I.

Decontamination operations began with the rotary-broom sweeper being used to clear road surfaces (see figure III-2a). Roofs of buildings were cleaned next, straight brooms being used on Buildings 505 and 506 and fire hoses on Buildings 504 and 507. Team B operated from the ground with a $2\frac{1}{2}$-inch hose equipped with a 1-inch bore nozzle, whereas Team A worked from the ridge of the roof using a $1\frac{1}{2}$-inch hose and $\frac{3}{4}$-inch bore nozzle.

To decontaminate land areas, Team B used the 99-H road grader and the towed scraper (pan loader) pulled by the MRS tractor (see figure III-2b). Team A used the tracked front-loader (see figure III-2c) and the D-8 bulldozer with straight push blade (see figure III-2d). Hand shovels were used by both teams. Cleanup consisted of windrowing the snow and pushing or hauling it out of the area.

3.2.3 Decontamination of Sector II.

The road dividing the two sectors was again cleared by rotary broom sweeping. Because of the difficulties encountered during the roof decontamination by fire-hosing of Buildings 504 and 507, the roofs of Buildings 514 and 518 in Sector II were not spread with fallout simulant. The one-story-building roofs were decontaminated by sweeping.

The land area in Sector II was cleared by use of the same general techniques as those employed in Sector I, but with some variation in equipment. Team B used the front loader, D-8 bulldozer, and the OC-9 road grader. Team A used the pan loader, 99-H road grader, and the D-7 bulldozer with angle blade. Again, both teams used shovels in areas that could not be reached with mechanized equipment.

3.3 Test Measurements.

Due to irregularities in surface areas, the presence of surface obstacles, and the inaccessibility of certain areas, the scanning equipment used to measure radiation levels of the test plots (Sec. II) could not be used during the logistics exercise. Instead, activity levels on surface areas were measured with a Nuclear Chicago Model 2586 "Cutie Pie" radiation detection meter and an Eberline Model E-200A radiation survey meter. The E-200A was used on the roofs.

Figure F-1 in Appendix F shows at what points on the ground complex dose rates were measured before and after decontamination. These points, in general, were located every 25 feet in rows approximately 25 feet apart. Dose rates were also measured on the roofs and inside the buildings; the locations of these measurements are shown in figures F-2 through F-6.

(a) Sweepster Clearing Road Between Sectors I And II

(b) Motor Grader And Pan Loader Pulled By MRS Tractor

FIGURE III-2 DECONTAMINATION OF GROUND COMPLEX DURING LOGISTICS EXERCISE

(c) Front Loader Removing Snow From Bar Ditch

(d) Bulldozer Pushing Snow Off Test Area

FIGURE III - 2 (CONT'D)

3.4 Results and Discussion.

The measurements taken on the ground complex, inside the buildings and on the roofs, are tabulated in Appendix F. Figures III-3 and III-4 show how each team utilized its equipment and manpower, while table III-2 shows, in the next-to-the-last column, the average percent of activity removed from the ground complex and the roofs of the one-story buildings. The average percentage of remaining radiation levels inside the buildings are listed in table III-3.

In Sections 3.4.1 through 3.4.5, below, the performance of the various types of equipment and the operational techniques developed during the exercise are noted.

3.4.1 Towed Scraper (Pan Loader).

Operation of the pan loader with the rubber-tired MRS tractor was marginal under the existing conditions. Poor traction in the snow resulted in the vehicle getting stuck several times. Water on the ground as a result of hosing the roofs increased the difficulty of operating this machine. After the area had been partially cleared, less difficulty was encountered, although operation still was slow.

3.4.2 Motor Grader.

The grader was quite successful in cleaning the material from around the foundation of the buildings. However, this machine is basically a withdrawing device and is not suitable for moving large quantities of material from one area to another. Operation of the grader with the pan loader to pick up the windrow is slow, but effective.

3.4.3 Front Loader.

The D-4 front loader was used to pick up snow around obstacles such as porches, hydrants, and trees. The capacity of the scoop is so limited, however, that the quantity of material removed by this machine during the test was relatively insignificant.

3.4.4 Bulldozer.

The D-8 bulldozer was the most efficient machine used in the logistic exercise. The technique developed to move the snow to the dump area was to open one lane through the snow that extended from the rear of the test area to the dump. All loads were then pushed down this lane to the dump, the windrow built up on each side of the lane helping to hold the snow on the blade until the dump was reached. The load pushed by the D-8 was two to three times as large as that carried by the pan loader. Since the D-8 did not get stuck, the average travel time was approximately one-half that of the pan loader. The D-8 was also able to clean out the ditch more effectively than the grader, and

TABLE III-2

SUMMARY OF ROOF AND GROUND-COMPLEX DATA

	Team	Section	Area	Time to Decontaminate	Number of men	Man-Hours per 1000 ft^2	Activity Removed
			(ft^2)	(min)			(%)
SECTOR I	A	Bldg 506 - Roof	3,600	50	4	0.93	81
		Ground Complex	23,300	180	4	0.33	47
	B	Bldg 505 - Roof	3,600	57	4	1.05	84
		Ground Complex	20,830	216	11	1.19	54
SECTOR II	A	Bldg 516 - Roof	3,600	57	4	1.05	80
		Ground Complex	45,470	300	6	0.27	75
	B	Bldg 517 - Roof	3,600	80	4	1.48	83
		Ground Complex	21,300	300	9	1.93	81

NPC 16,616

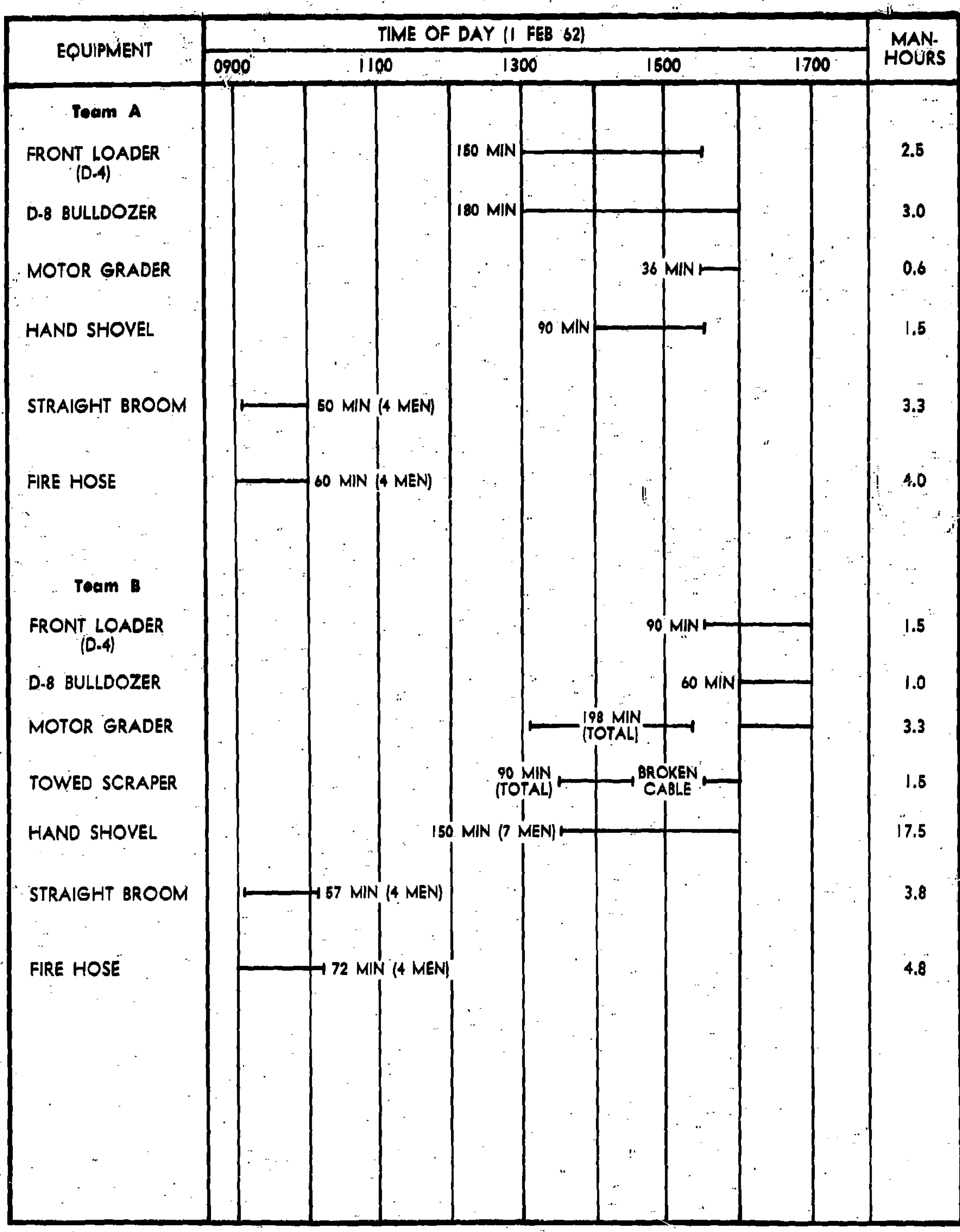

FIGURE III - 3 EQUIPMENT AND MANPOWER UTILIZATION: SECTOR I

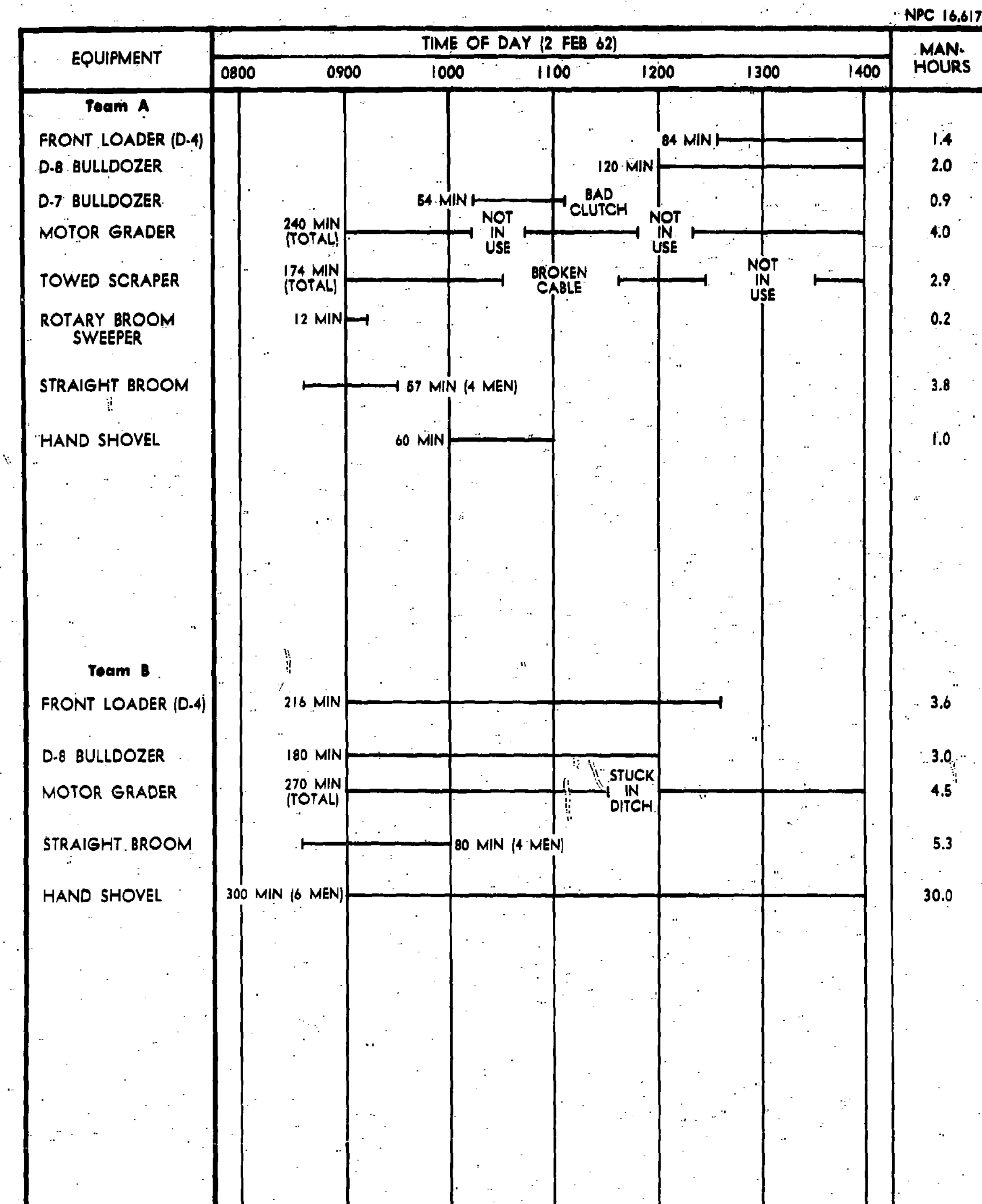

FIGURE III-4 EQUIPMENT AND MANPOWER UTILIZATION: SECTOR II

TABLE III-3

EFFECT OF DECONTAMINATION ON RADIATION INTENSITY LEVELS INSIDE BUILDINGS

Building Number		Average Percentage of Remaining Radiation Intensity*	
		After Roof Decontamination	After Roof & Ground Decontamination
504	Upper Floor	108	69
	Lower Floor	134	63
505		94	34
506		103	40
507	Upper Floor	81	51
	Lower Floor	96	40
514**	Upper Floor	-	27
	Lower Floor	-	23
516		-	21
517		-	20
518**	Upper Floor	-	19
	Lower Floor	-	18

* The percentages in the table are average values of all readings taken inside the buildings (Appendix F).

** Roof was not contaminated.

was considerably faster than the D-4 front loader. The speed of the D-8 is reflected in the cleanup times required for each area.

3.4.5 Fire Hose.

The roofs of Buildings 504 and 507 in Sector I iced over during the hosing operation, so that the decontamination data could not be obtained for three days. After correcting for decay, the residual activity still on the roofs was not significantly lower than the initial spread activity, and in some places it was higher. In addition, the low level of radioactivity after three days made it necessary to take readings with the Eberline E-200A meter, which froze several times during data-taking and required several thawings. It is suspected that a slow instrument drift may have occurred during this time period to contribute to the uncertainty of these data.

3.5 Summary.

Evaluation of the effectiveness of the various decontamination methods applied in the Logistic Exercise is very complex because of the many variables involved. This test was essentially a one-decontamination operation utilizing several combinations of techniques and machinery. Specific evaluation of each method and tool as applied to a given surface environment was not feasible except in a few instances.

Information gained from the decontamination of Sector I indicated that both crews could work more effectively with a D-7 or D-8 bulldozer and a grader. However, because of breakdowns and time required to transport the D-7 from the equipment pool, this combination of equipment was in operation only part of the time for both teams. Enough experience was gained, however, to demonstrate that this combination was the most efficient of those tested for removing the material from land areas. It is felt that the payloader, which was not available for this test, would also be effective in this type work.

For decontaminating bare roofs at temperatures below 32°F, the straight push broom is recommended over the fire hose. Although sweeping requires more time than hosing, the percentage of radioactivity removed is greater and the hazard presented by an icy roof is avoided. In either case, the radiation intensity inside the building will tend to increase from concentration of fallout on ground immediately adjacent to building walls. This is removed by subsequent ground decontamination.

There are several items of interest that can be surmised from the complex data results. Probably the major observation is that to effectively decontaminate large snow-covered areas, a team consisting of a dozer and a grader is required. In Sector I, Team A had a D-8 dozer which moved large amounts of snow from the area, but produced a low decontamination effectiveness. Team B had a motor grader which was seriously handicapped by the large bulk of snow. The result was only

50% decontamination for the sector. In Sector II, where both teams used a dozer to remove the majority of the snow, and then used a motor grader to scalp the surface to bare ground, the effectiveness was increased to 75% or 80%.

Another notable observation is the large difference between the man-hour expenditure of Team A and that of Team B. This difference was due almost entirely to hand shoveling. It is doubtful if the greater effort and incurred dose is worth the less than 10% increased effectiveness in decontamination.

An estimate of expected dose for an operation of this type was made by using the data obtained in the test. By use of the average dose rates on the ground and roof at the time just before decontamination commenced, and the man hours of exposure, the total dose for the two teams was estimated at 2500 mr, or an average of 104 mr per man. According to the film badge results, the total average dose was 56 mr per man. Therefore, the combined effects of equipment shielding and reduction of dose rate due to decontamination resulted in each man receiving only 54% of the expected dose. Since this percentage would be considerably reduced by the elimination of the hand shoveling, it should be safe to conclude that for an operation of this type, the dose to each man would be less than half the open field dose during the same duration of time. For example, if the 3½-acre complex was at an H+1 intensity level of 2000 r/hr, it could have been decontaminated by a 24-man team after a two-week waiting period with an average dose to each man of about 4 r.

IV. FALLOUT MIGRATION TESTS.

The vertical and horizontal migration of fallout deposited on snow and ice could influence greatly the procedures required to effectively decontaminate an area. To obtain experimental data on the vertical and horizontal migration phenomena, a series of tests was conducted in which the migration of a non-radioactive tracer was measured under a variety of meteorological and ground-cover conditions.

4.1 Simulation of Fallout.

To simulate fallout, a fluorescent called Liquifluor was sprayed on native Camp McCoy sand that had been sieved to a particle size from 150 to 300 microns. This mixture, like the radioactive simulant used in the decontamination tests, was prepared in the U. S. Army Nuclear Defense Laboratory Facility (see Appendix A).

One thousand pounds of the sieved sand was loaded into the concrete mixer (see figure A-1) and sprayed with one liter of Liquifluor concentrate. To facilitate the mixing process, the fluorescent was diluted with one liter of toluene, which made a total volume for spraying of 2000 cc. After the Liquifluor solution was injected, the sand was tumbled and dried in the mixer for two hours and then stored in 35-gallon cans for later use.

4.2 Preparation of Test Plots.

The snow used for the migration tests was located in an open field approximately 400 feet long by 300 feet wide bordered by small trees. The ice for the tests was located in the bed of a large, open drainage ditch that was exposed to the weather.

The test plots on the snow were approximately 4 by 20 feet and were in a north-south direction, an east-west direction, and a northeast-southwest direction (see figure IV-1a). By this means, the prevailing winds were likely to be in a direction nearly perpendicular to the long side of one of the plots. This method insured that the horizontal migration of the simulant off the opposite long side of the plot would be more evenly distributed. Thus, contamination measurements made downwind from the plot would be more nearly equal and their average more representative of the migration process. As it happened, the prevailing wind was northwesterly, so the NE-SW plot was utilized for the horizontal migration studies.

The sand used in these tests was left outdoors for approximately 3 hours prior to spreading so that it could come to temperature equilibrium. A Scott fertilizer spreader, Model 35-8, was used to spread the sand on both the ice and snow. Although the spreader had been adjusted to a spreading rate of 50 gm/ft^2, the nature of the

(a) Snow Test Plot

(b) Taking Snow Sample With Metal Box

(c) Taking Ice Sample With Corer

FIGURE IV-1 MIGRATION TESTS

surface being spread and the peculiarities of the spreader were such that a perfectly uniform dispersal could not be accomplished. To find the average amount per square foot, four samples were taken from each of the four spreads on snow and the two on ice. The results of these measurements are shown in Table IV-1.

TABLE IV-1

DISTRIBUTION OF SAND ON MIGRATION TEST PLOTS

Sample	Amount of Sand (gm/ft^2)					
	On Snow				On Ice	
	Plot 1	Plot 2	Plot 3	Plot 4	Plot 1	Plot 2
1	49.3	61.4	48.7	76.2	37.6	76.3
2	51.4	58.3	51.4	38.1	48.9	36.8
3	62.3	41.7	68.7	46.3	90.6	50.1
4	38.1	47.6	71.2	58.1	56.8	48.9
Average	50.3	52.3	60.0	54.7	58.5	53.0
	Average = 54.3				Average = 55.8	

4.3 Equipment.

A rectangular metal box with the front and one end open was used to obtain the snow samples for analysis (see figure IV-1b). The box measured 6 x 6 x 12 inches (ID) and had grooves for shelves placed on ½-inch centers.

The apparatus for coring ice consisted of a 1-15/16-inch ID pipe with a sawtooth edge on one end (see figure IV-1c).

The fluorometer utilized in these tests was designed and built at General Dynamics/Fort Worth. This instrument, containing General Electric 6WBLB lamps as an ultraviolet source and an RCA 5819 phototube with appropriate filters, was powered by a Fluke high-power supply, Model 400E, set at 740 v-dc. It was connected to a Beckman Model V micromicroammeter for readout.

4.4 Sampling and Testing Procedure.

The horizontal migration of the simulant on snow was tested by taking samples at distances of zero, one, two, and three feet from the test plots after time lapses of 24, 48, and, when possible, 72 hours. Migrations beyond three feet were below the sensitivity of the fluorometer.

The samples of snow were collected by inserting the empty coring box into the snow as demonstrated in Figure IV-1b. Excess snow was then removed from the front of the box, and the metal shelves were inserted, starting at the bottom and progressing upward. Sampling from low concentrations to high concentrations reduced the error of cross contamination.

The samples of ice were collected by boring four inches into the ice, removing this core, and cutting it into $\frac{1}{4}$-inch increments with a small coping saw.

After the snow and ice samples were collected, they were put in 600-mℓ beakers and placed in an oven at 110° C. After drying, they were cooled to room temperature and 14 cc of toluene added to each sample. The toluene was stirred with the sand for two minutes to extract the Liquifluor. The solution was then filtered through a Whatman No. 40 filter paper directly into a 15-mℓ vial, which was placed into the fluorometer for reading. (The method of converting μammeter readings to Liquifluor concentration is described in Appendix G.) All glassware was rinsed with toluene and washed with Alconox between runs to prevent cross contamination.

4.5 Results and Discussion.

Tabulation of the measurements recorded during the migration tests are presented in Appendix G, Tables G-1 through G-6.

Figures IV-2 through IV-5 and IV-6 through IV-7 show plots of the vertical and horizontal migrations, respectively, as a function of the various meteorological and ground-cover conditions.

4.5.1 Vertical Migration Tests.

Undisturbed Snow Covered by Loose Snow. The vertical migration through undisturbed snow covered by loose snow on a partly cloudy day is shown in Figure IV-2. The data are an average of two samples for each test conducted. Temperatures ranged from -6° F to +29° F and wind velocities from 5 to 18 mph. Samples were taken vertically every $\frac{1}{2}$ inch until no simulant could be detected. The snow averaged 4.8 inches deep with a density of 0.363 gm/cc and consisted of $\frac{1}{2}$ to $\frac{3}{4}$ inch of loose new snow over a hard crusty surface. Tests were terminated after 48 hours due to the onset of a heavy thaw.

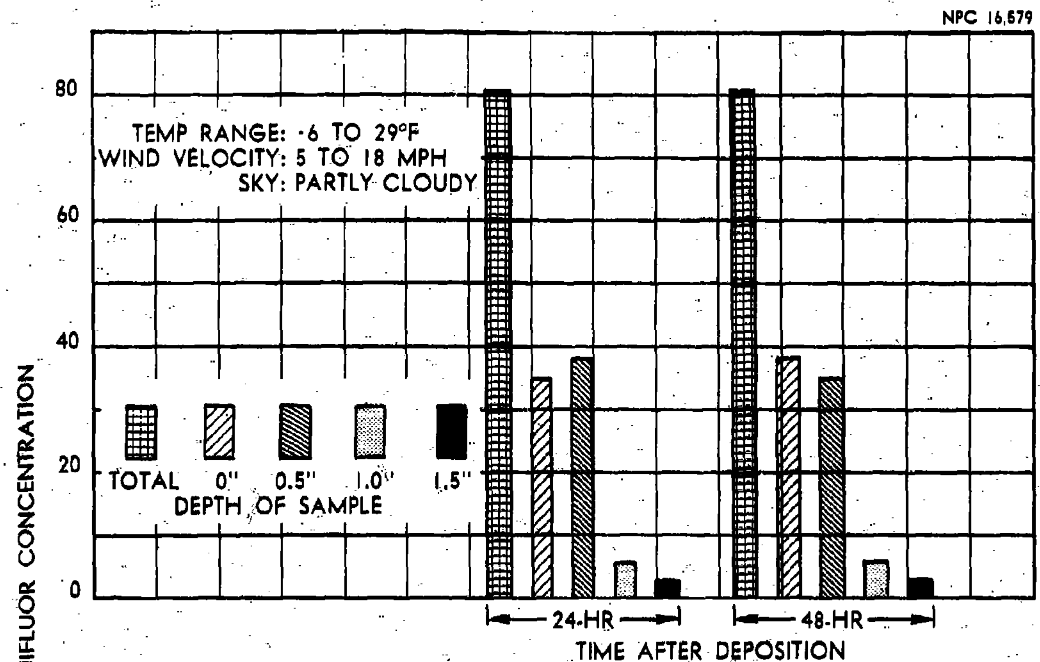

FIGURE IV-2 VERTICAL MIGRATION OF FALLOUT THROUGH UNDISTURBED SNOW COVERED BY LOOSE SNOW

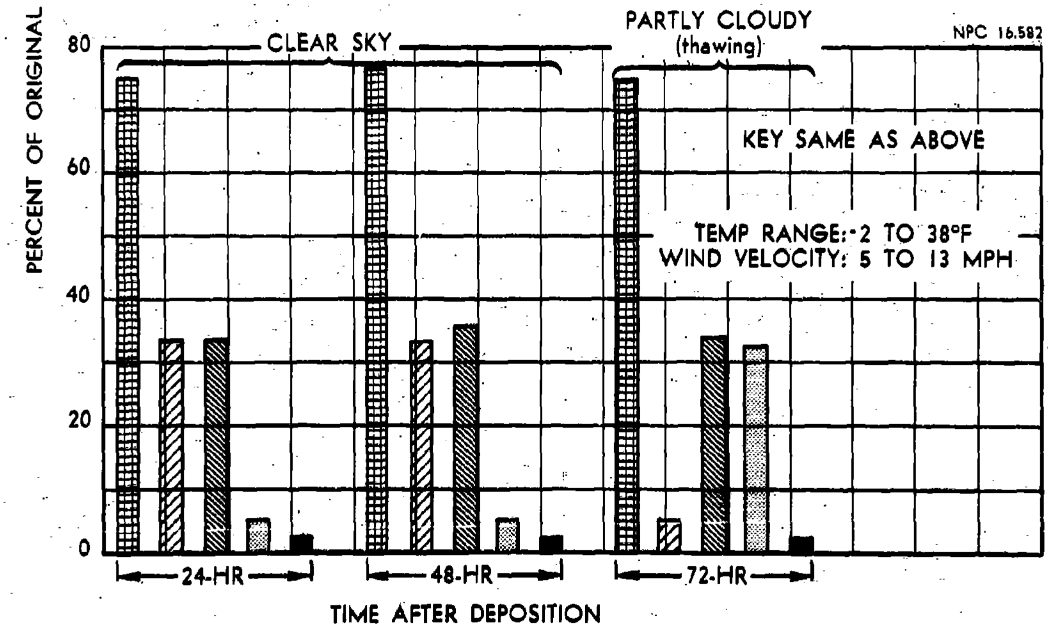

FIGURE IV-3 VERTICAL MIGRATION OF FALLOUT THROUGH UNDISTURBED SNOW

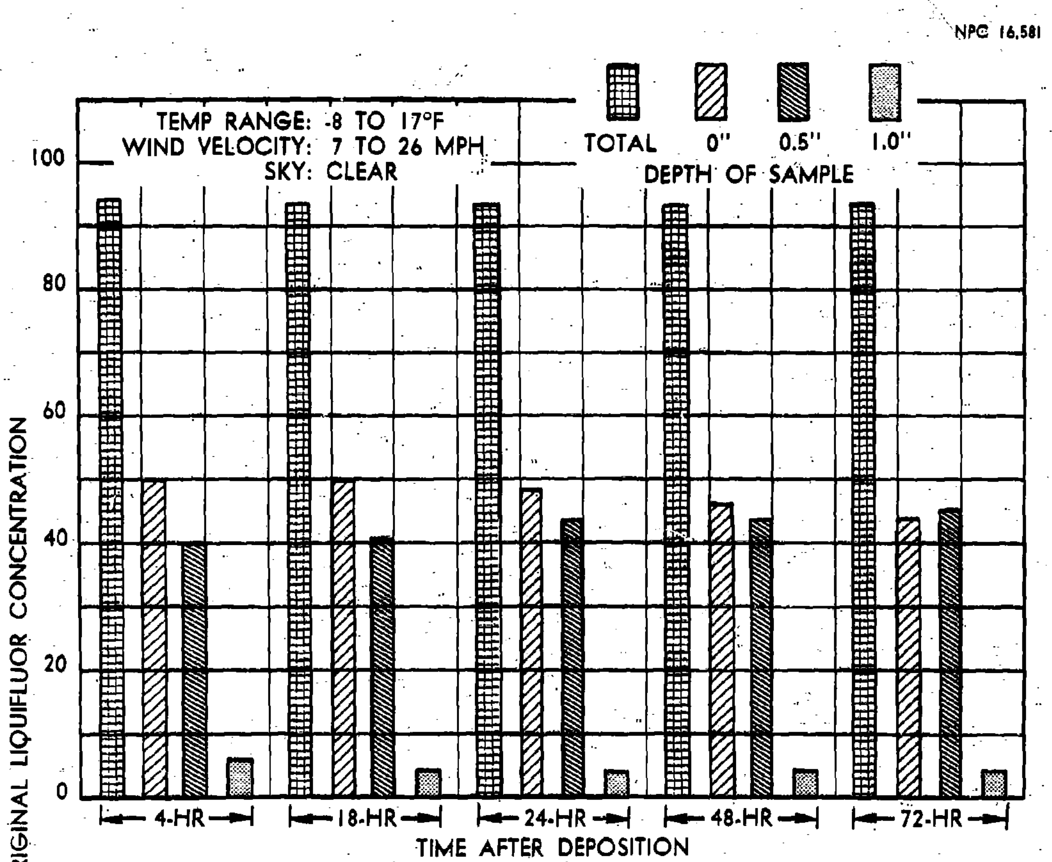

FIGURE IV-4 VERTICAL MIGRATION OF FALLOUT THROUGH CRUSTED, UNDISTURBED SNOW

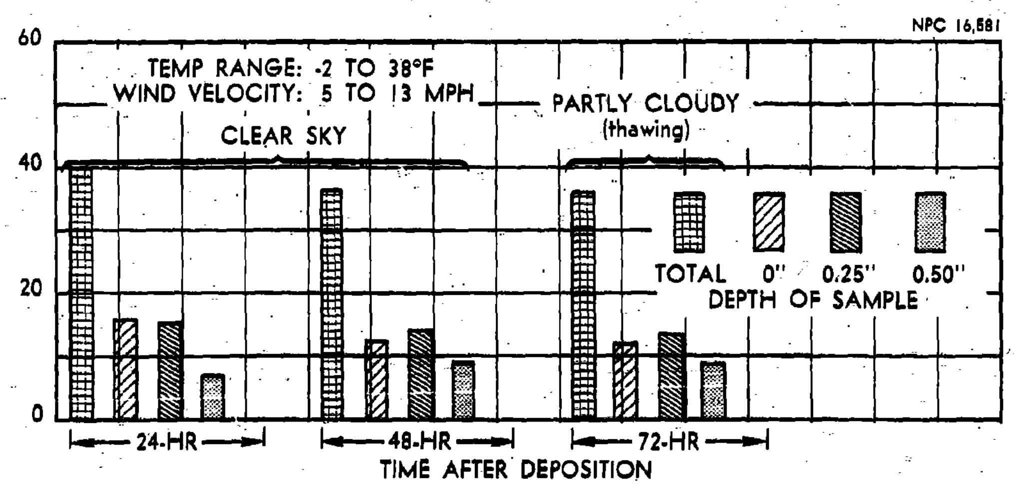

FIGURE IV-5 VERTICAL MIGRATION OF FALLOUT THROUGH ICE

Undisturbed Snow. The vertical migration through undisturbed snow on two clear days and one cloudy day is shown in Figure IV-3. The data are an average of two samples for each test conducted. Temperatures ranged from -2°F to +38°F and wind velocities from 5 to 13 mph. Samples were taken vertically every ½ inch until no simulant could be detected. The snow averaged 5.5 inches deep with a density of 0.301 gm/cc and was of a somewhat loosely packed nature. Thawing occurred during the last 24 hours of this test.

Crusted, Undisturbed Snow. The vertical migration through crusted, undisturbed snow on clear days is shown in Figure IV-4. The data are an average of two samples for each test conducted. Temperatures ranged from -8°F to +17°F and wind velocities from 7 to 26 mph. Samples were taken vertically every ½ inch until no simulant could be detected. The snow averaged 4.0 inches deep with a density of 0.361 gm/cc and had a hard crystalline structure. This test was conducted after five days of thawing conditions.

Ice. The vertical migration through ice on two clear and one partly cloudy day is shown in Figure IV-5. The data are an average of two samples for each test conducted. Temperatures ranged from -2°F to +38°F and wind velocities from 5 to 13 mph. Samples were taken vertically every ¼ inch until no simulant could be detected. The ice depth averaged 6 to 8 inches, with a slightly roughened surface. The 72-hour sample was taken during a slight thaw which did not seem to affect the results.

4.5.2 Horizontal Migration Tests.

Crusted, Undisturbed Snow. The horizontal migration through crusted, undisturbed snow on three clear days is shown in Figure IV-6 (2 pages). The data are an average of two samples for each test conducted. Temperatures ranged from -8°F to +17°F and wind velocities from 7 to 26 mph. Each sample was taken horizontally at 1-foot increments off the original plot and at ½-inch increments in the vertical direction. Samples were taken both horizontally and vertically until no simulant could be detected. The snow averaged 4.0 inches deep with a density of 0.361 gm/cc and had a hard crystalline structure. These series of tests were conducted after five days of thawing conditions.

Shown is the fraction of total simulant deposited at each level and distance from original plot for four different times after deposition.

Undisturbed Snow. The horizontal migration through undisturbed snow on two clear days is shown in Figure IV-7. The data are an average of three samples for each test conducted. Temperatures ranged from -2°F to +38°F and wind velocities from 5 to 13 mph. Samples were taken both horizontally and vertically until no simulant could be detected.

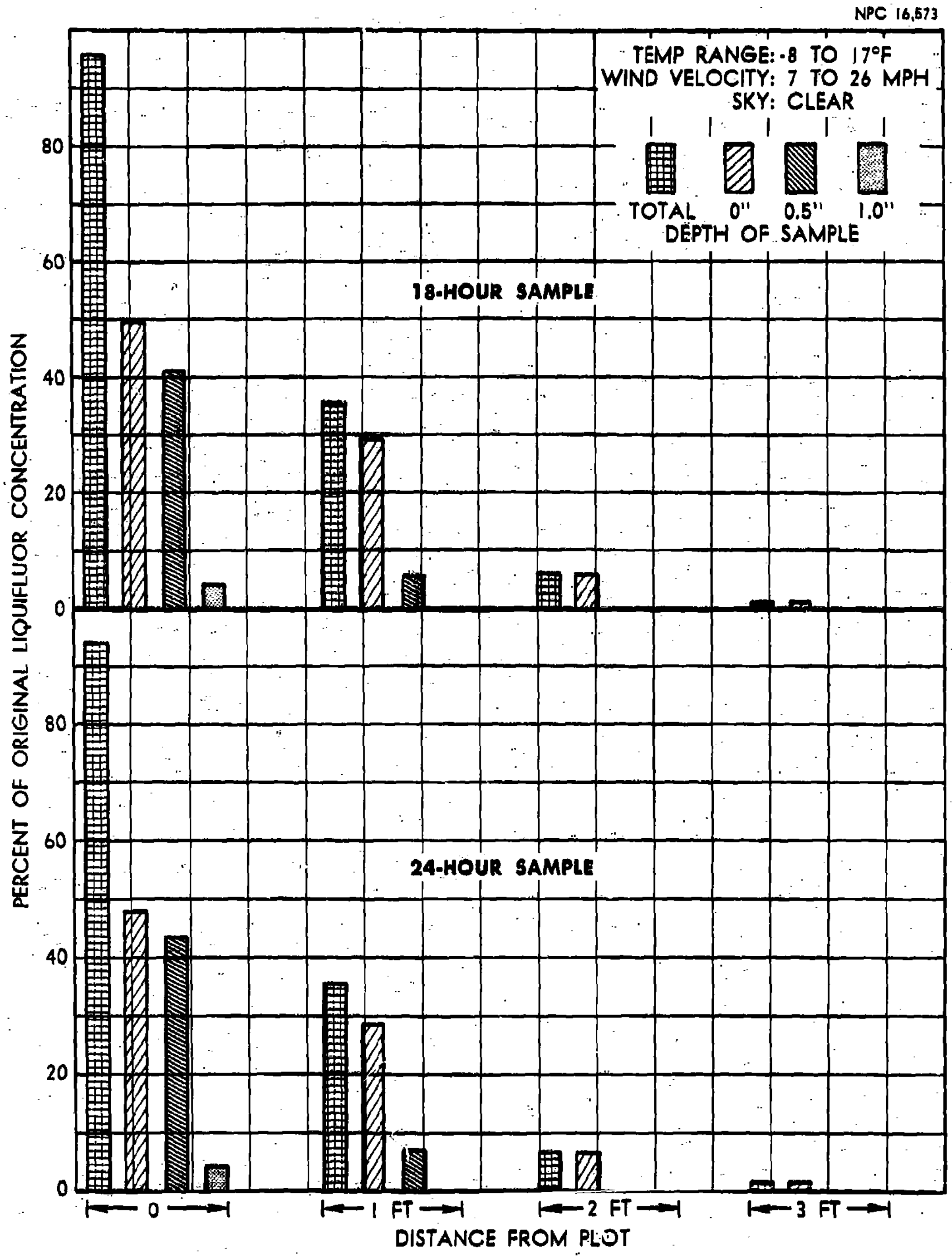

FIGURE IV-6 HORIZONTAL MIGRATION OF FALLOUT THROUGH CRUSTED, UNDISTURBED SNOW

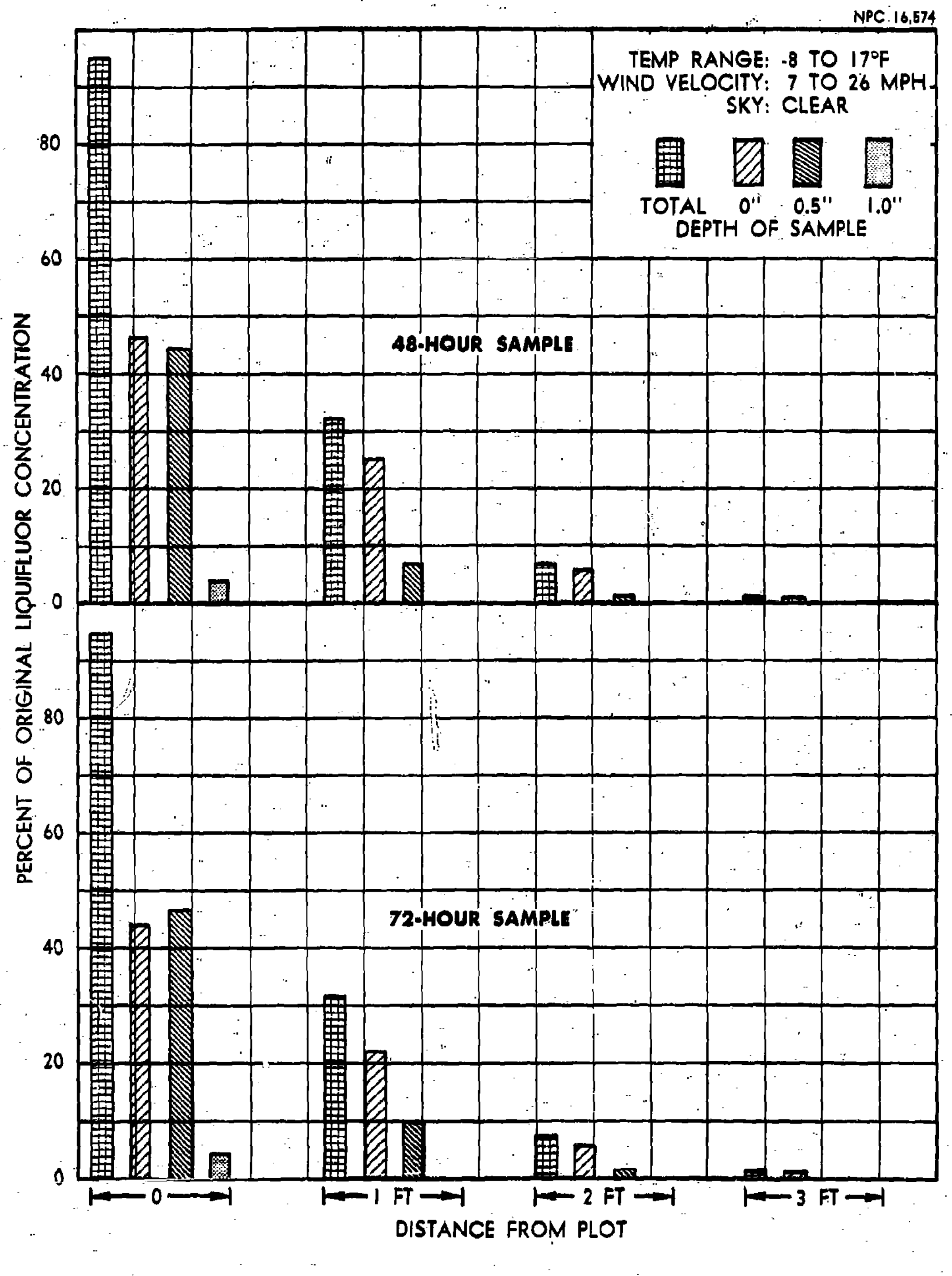

FIGURE IV-6 (Cont'd)

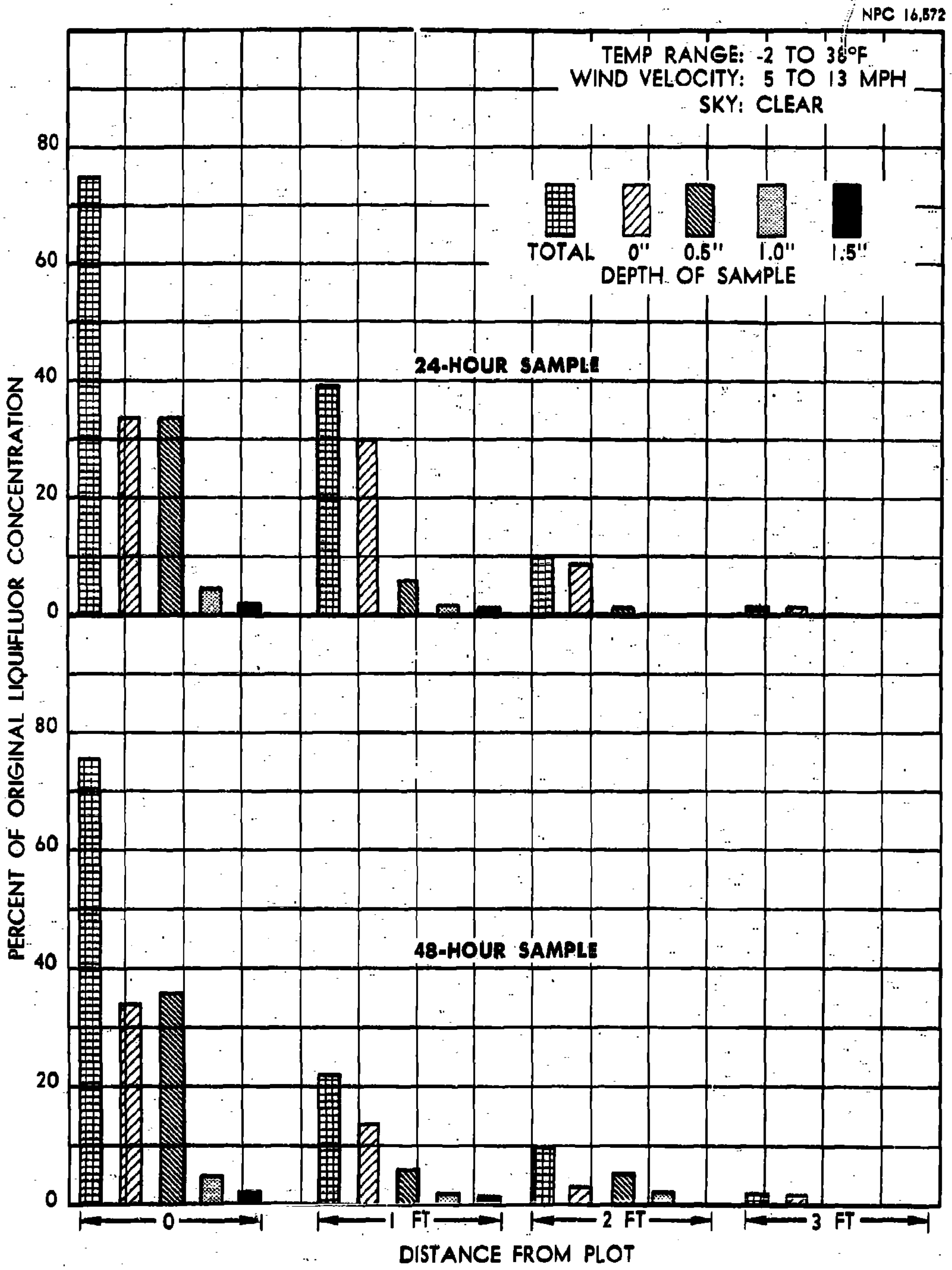

FIGURE IV-7 HORIZONTAL MIGRATION OF FALLOUT THROUGH UNDISTURBED SNOW

The snow averaged 5.5 inches in depth with a density of 0.301 gm/cc and was of a somewhat loosely packed nature. The test was terminated after 48 hours at the onset of a heavy thaw.

4.5.3 Test Results.

A study of migration measurements (see Appendix G) indicates that most of the migration of fallout simulant takes place within 24 hours after original disposition. In all but one of the tests there was no significant change in the simulant distribution after the first time lapse. The exception was the vertical migration of simulant on undisturbed snow between 48 and 72 hours following a thawing period.

The tests also showed that crusted snow had a higher retention of simulant (about 95%) than loose snow, which indicates less horizontal migration. The majority of the simulant remained in the top half-inch of the snow, and penetrated very little beyond the crust. Loose snow, on the other hand, retained from 15% to 20% less simulant than crusted snow, but vertical penetration was greater. In no instance was horizontal migration greater than 3 feet; but no high winds or heavy drifting was experienced during the test period.

The migration test on ice showed approximately only 40% retention of simulant, which indicated greater horizontal migration than that on snow. Again, there was no significant change in the vertical migration profile after 24 hours, although there were intermittent thawing periods. There was a slight decrease in the surface concentration over the span of the test, which indicated possible continuation of horizontal migration.

V. SHIELDING TESTS

Knowledge of the effectiveness of snow and ice in attenuating gamma rays emitted by fallout would be useful in predicting the dose rate to personnel engaged in cold-weather decontamination operations. Such information would also be useful in calculating the protection that would be effected by a snowfall subsequent to a contaminating event.

As part of the overall field program in cold-weather decontamination operations, two tests were conducted to measure the shielding effects of snow and ice. More tests were planned but had to be cancelled because of damage to cesium-137 sources during shipment to the test site.

5.1 Experimental Procedure and Equipment.

For the snow studies, two cylindrical 0.5-curie cesium-137 sources measuring 0.5 x 1.5 inches were used. The sources were inserted in the snow to ground level and the hole filled with 5 to 7 inches of snow having a density of 0.310 gm/cc and 0.5 to 0.75 inch of loose snow having a density of 0.190 gm/cc. Measurements were taken with a Nuclear Chicago Model 2586 radiation detection meter and an Eberline E-200A radiation survey meter positioned three feet above the surface of the snow. Horizontal measurements were taken at 1-ft intervals out to 4 ft and at 2-ft intervals from 4 to 32 ft.

For the ice studies, the same two sources were utilized. The sources were inserted into an 11-inch-deep hole bored into the ice, and the hole was then filled with ice chips and packed down to simulate solid ice. On top of the ice was a 2-inch layer of loose snow (density = 0.190 gm/cc). The ice density was 0.920 gm/cc. Measurements were taken three feet above the surface with the two instruments used in the snow tests. Horizontal measurements were taken at 1-ft intervals out to 4 ft and at 2-ft intervals from 4 to 22 ft.

In order to determine the effectiveness of the snow and ice shielding, horizontal measurements were taken out to 30 ft with the sources unshielded - placed on top of the ice.

The dose-rate measurements for both the snow and the ice studies are listed in Table V-1.

5.2 Calculational Methods.

For the preceding geometries, it may be assumed that the source was being moved rather than the detector. Integration may then be performed over the surface area and the resultant dose rate from a plane

TABLE V-1

SHIELDING EFFECTIVENESS OF ICE AND SNOW

Distance From Two 0.5-curie Ce^{137} Sources (ft)	Dose Rate (mr/hr)*					
	No Shielding**	Source Covered by Snow to Depth Indicated			Source Covered by 11 in. of Ice	
	Cutie Pie	Depth of Snow (in.)	Cutie Pie	E-200A	Cutie Pie	E-200A
1	400	7	245	-	115	-
2	300	6	230	-	80	-
3	215	6	170	-	50	-
4	160	6	110	-	30	-
6	95	6	60	-	11.5	10
8	55	6	35	-	5	4
10	35	6	19	15	3	2
12	25	7	11.5	8	2	1.5
14	17.5	6.5	7.5	6	-	0.70
16	14	8.5	5.5	4	-	0.50
18	11	8.0	4	3	-	0.37
20	9	7.5	3	2.5	-	0.25
22	7	7.5	-	1.5	-	0.20
24	6	7.5	-	1.0	-	-
26	5	7.5	-	0.9	-	-
28	4	7.5	-	0.8	-	-
30	3	7.5	-	0.6	-	-
32	-	7.5	-	0.5	-	-

*Measurements were made 3 feet above surface
**Source on top of ice

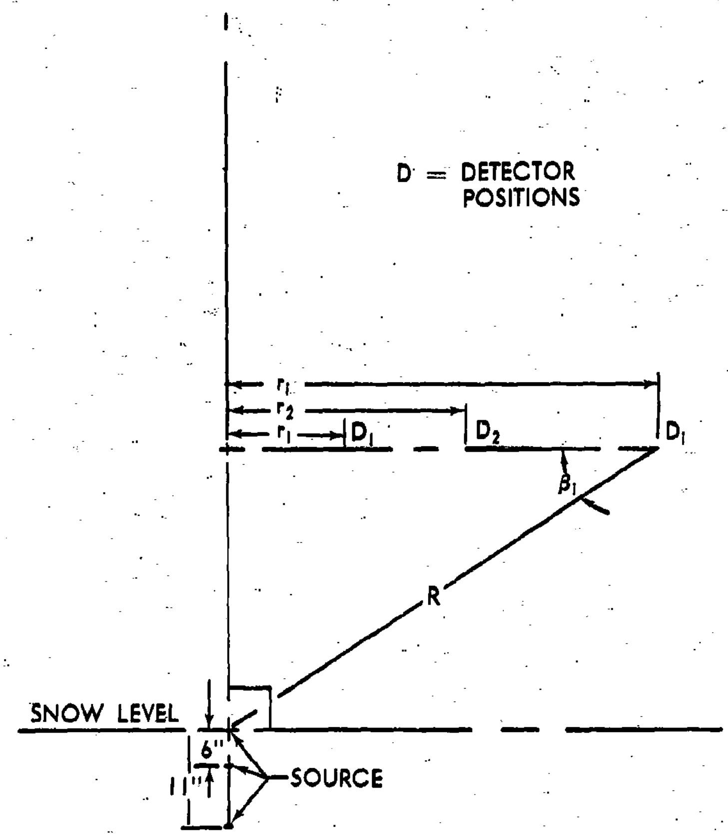

FIGURE V-1 EXPERIMENTAL GEOMETRY

isotropic source determined by the following equation:

$$\text{Dose Rate} = 2\pi \int_0^{r_{max}} D(r)\, r\, dr,$$

where D(r) is the measured dose rate at a distance r listed in Table V-1. Figure V-1 shows the experimental geometry. Using the above equation, dose rates have been calculated for three of the experimental conditions. They are shown in Table V-2 along with the equivalent water thicknesses.

TABLE V-2

DOSE RATES CALCULATED FROM MEASURED VALUES

Geometry	Dose Rates $\left(\frac{mrem}{hr}\right) / \left(\frac{curie}{cm^2}\right)$	Equivalent Thickness of Water (in.)
No covering	5.0×10^7	0
6" Snow	2.8×10^7	1.79
9" Ice 2" Snow	6.4×10^6	8.9

The dose rates can be calculated numerically for various thicknesses of water by use of the following equation:

$$\text{Dose Rate} = \int_0^{2\pi} \int_0^{r_{max}} \frac{SF}{4\pi R^2} B\,(\mu t/\sin \beta) e^{-(\mu t/\sin B)} r\, dr\, d\theta,$$

where

S is the source strength $\left(3.7 \times 10^{10} \frac{\text{disintegrations}}{\text{sec}} \times \frac{1 \text{ photon}}{\text{disintegration}}\right)$;

F is the flux-to-dose conversion $\left(1.335 \times 10^{-3} \frac{\text{rem/hr}}{\text{photon/sec}}\right)$;

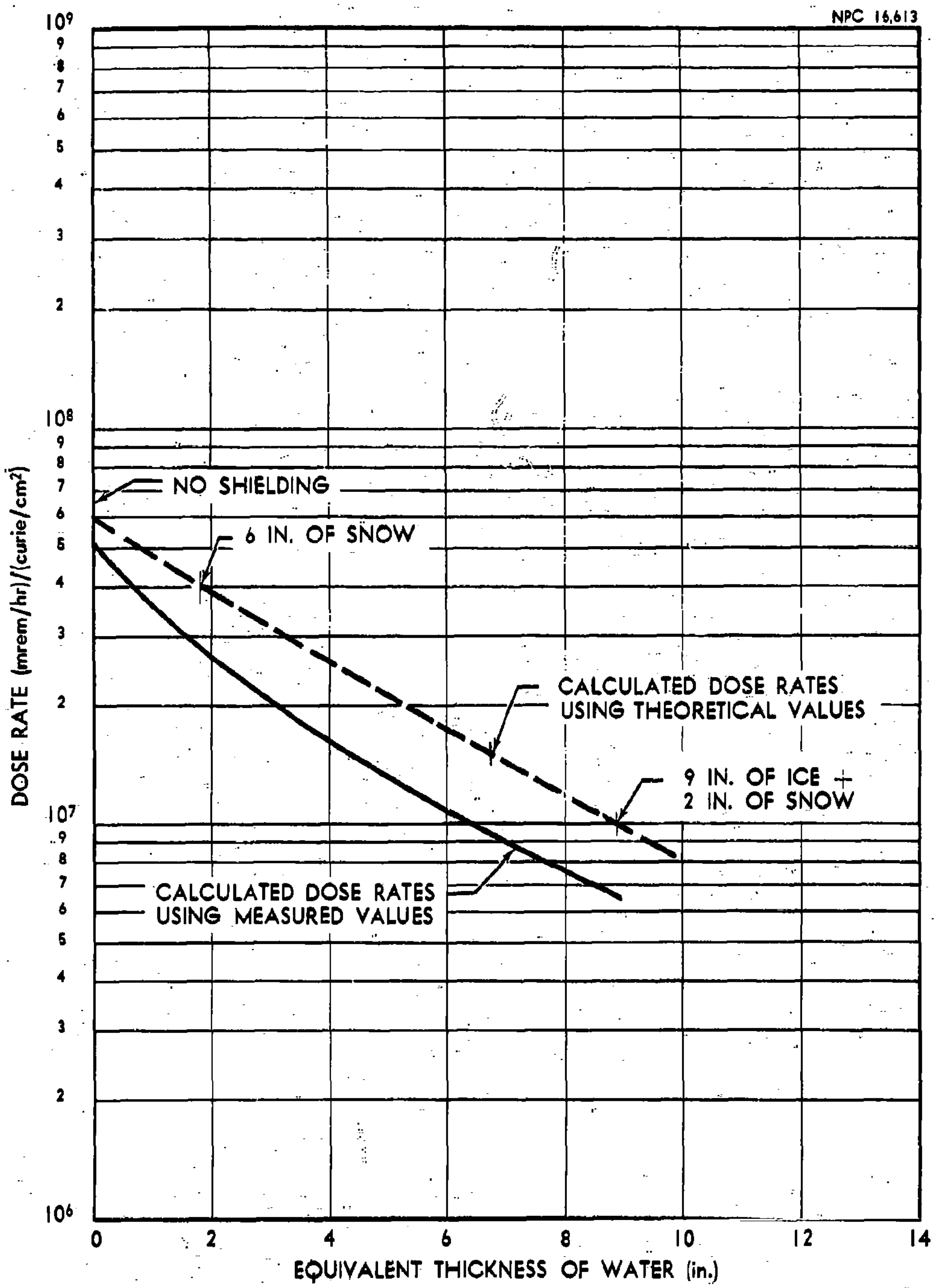

FIGURE V-2 SHIELDING EFFECTIVENESS OF WATER

r is the horizontal distance of the detector from a vertical line through the source;

R is the line-of-sight distance from the source to the detector;

β is the angle measured by the intersection of r and R;

$B(\mu t/\sin \beta)$ are the infinite media buildup factors;

t is the thickness of water; and

θ is the angle measured about a vertical line through the source.

Figure V-2 compares the calculated and measured dose rates for water thicknesses equivalent to no shielding, 6 inches of snow, and 9 inches of ice plus 2 inches of snow. The discrepancy between measured and predicted dose rates is attributed to three main causes: (1) use of infinite-media buildup factors in a finite medium (no other factors exist for use in this type of case); (2) neglect of air attenuation; and (3) accuracy of the detection instruments in measuring low-gamma-energy radiation.

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APPENDIXES

APPENDIX A

PRODUCTION OF RADIOACTIVE FALLOUT SIMULANT

The fallout simulant used in this series of tests was produced in the U. S. Army Nuclear Defense Laboratory Facility at Camp McCoy. Radioactive tracer materials are manufactured at this plant by combining a radioactive isotope with a suitable carrier (sand), adding a binder or sealer (sodium silicate), and then baking or firing the material to form the end product. This procedure is demonstrated in the sequence of photographs in Figure A-1 and in the flow diagram of Figure A-2. The steps involved in the simulant production are as follows:

1. The mixer is preheated and the carrier loaded and heated.

2. The isotope and binder are added to the carrier via lances.

3. The wet simulant is dried in the mixer.

4. The dried simulant is dumped from the mixer to the belt conveyor, which carries it to the bucket elevator and on into the metering hopper.

5. The dried simulant is loaded into pans.

6. The pans are pushed into the furnace where the dried simulant is baked.

7. The pans are removed from the furnace and left on the skid rails to cool.

8. The simulant is dumped into the roll-grinder receiving bin.

9. The simulant is fed through the roll grinder to the final hopper.

A-1. Simulant Production Equipment.

The various pieces of equipment and their operation are described in some detail below.

A-1.1 Simulant Mixer.

The simulant materials are initially combined in a heavy-duty concrete mixer of the type usually mounted on trucks. The mixer is fitted with internal resistance heaters and a port in the butt plate for admission of either the lances or a forced-draft heater. A loading

port is provided on the periphery of the plate through which the carrier material is admitted. A filtered exhaust fan and cleanout trap are attached to the loading end of the mixer. The sand is emptied from the mixer by means of a modified chute-type unloader.

The mixer loader consists of a belt conveyor, collecting bin, and dump pipe. The dump pipe is inserted into the mixer through the loading port and the carrier material, which is carried by the belt conveyor to the collecting bin, is gravity fed through the dump pipe into the mixer.

The lances provided for the applications of the isotope and the silicate binder are quite similar, consisting of two pipes sealed through a metal disc which can be fitted over the port provided in the butt plate. The outer ends of the pipes are fitted with hose connections, the inner ends with an atomizing nozzle. Solutions pumped into the lances through a feed line are atomized and deposited on the carrier material in the mixer by the action of carrier gas released through the nozzle.

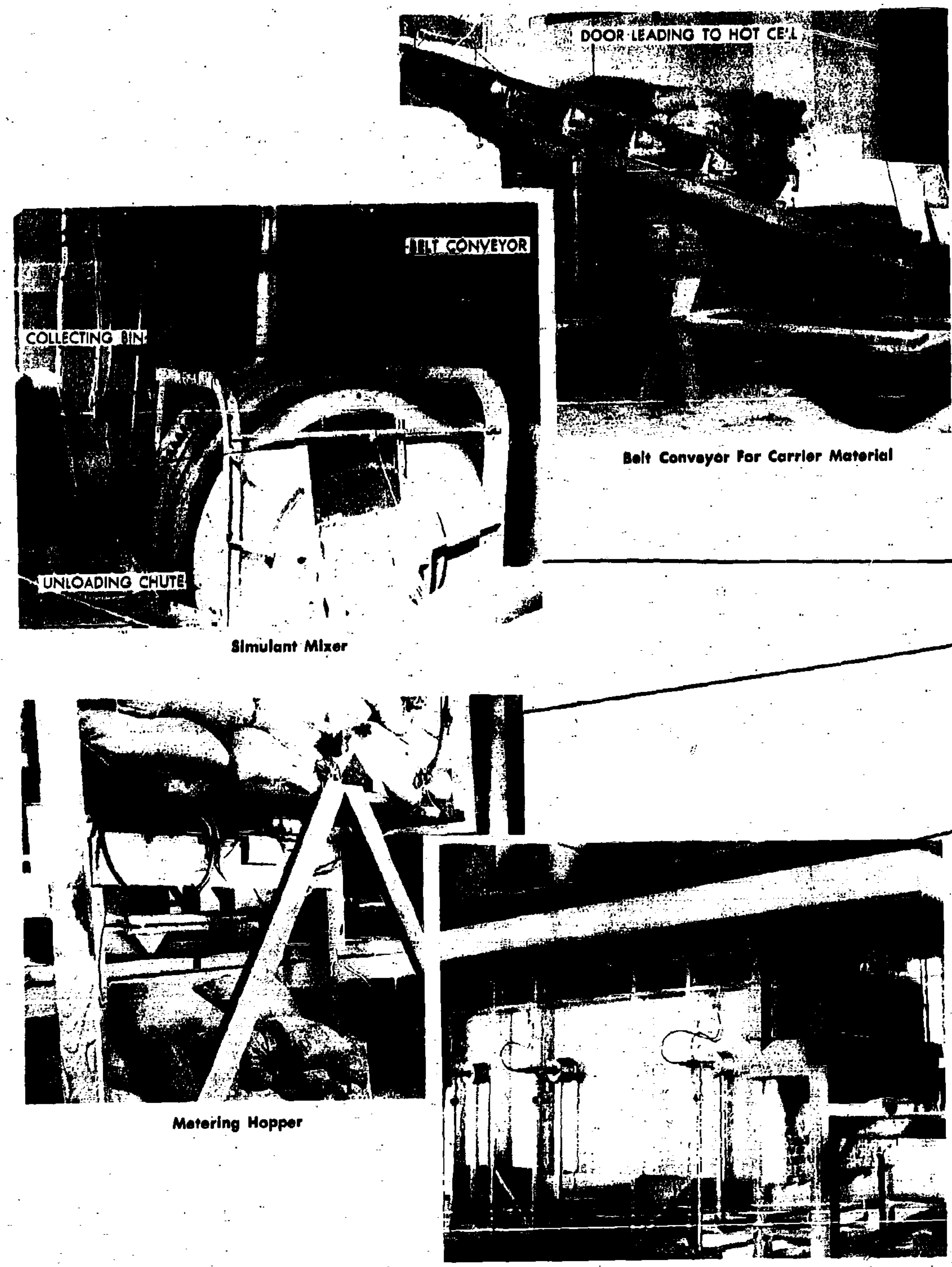
A-1.2 Metering Hopper and Loading System.

A belt conveyor and bucket elevator carry the simulant from the mixer to the metering hopper. The simulant is poured directly from the mixer unloading chute onto a belt conveyor and dumped into a bucket elevator which loads a metering-hopper storage bin.

The metering hopper is a known-volume bin fitted with sliding closures at the top and bottom and operated by a pneumatic ram. It is gravity fed through an orifice from the storage bin. Once full, the upper slide is closed and the lower slide opened, releasing the metered sand into 24 x 18 x 2-inch stainless-steel pans. The pans loaded with simulant are pushed along the two skid rails by a hydraulic ram to the furnace. A roller conveyor is mounted at right angles to the furnace feed line for the admission of additional pans to the line.

A-1.3 Furnace.

The furnace consists of a firebox of fire brick having six burners - three to a side - mounted approximately $2\frac{1}{2}$ feet from the floor of the box. Diesel oil or similar fuel can be used in the burners; Number 2 diesel oil was used during the current series. Atomizer air is supplied by a two-stage compressor set to maintain a tank pressure of from 90 to 120 pounds. A radial fan mounted on the firebox supplies combustion air. Fuel is pumped from a tanker truck by a positive displacement pump with a bypass set for a fuel pressure of 40 pounds. Both fuel and atomizer air are manifolded to the six burners and controlled by individual needle valves at each burner.



Belt Conveyor For Carrier Material

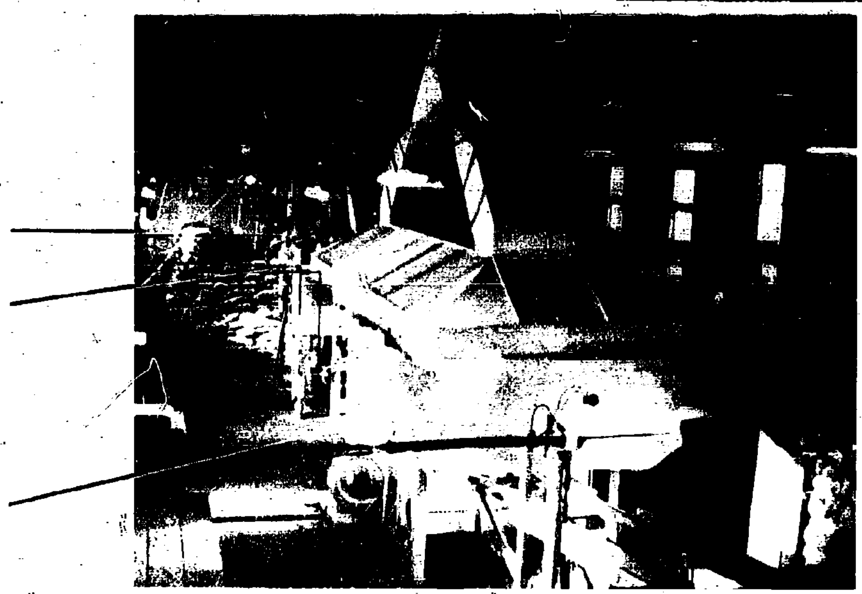
Simulant Mixer

Metering Hopper

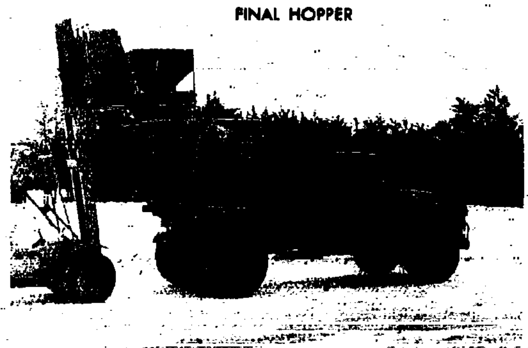
Furnace

FIGURE A-1 FALLOUT-SIMULANT

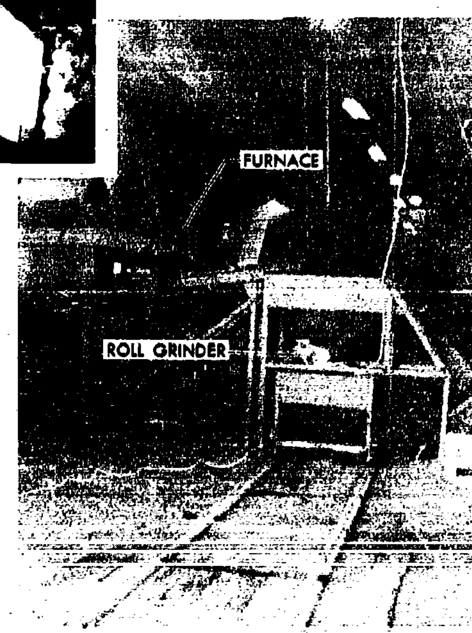
Simulant Production Facility



FINAL HOPPER



Blender For Radioactive Sand
With Cold Sand



Final Hopper

PRODUCTION FACILITY

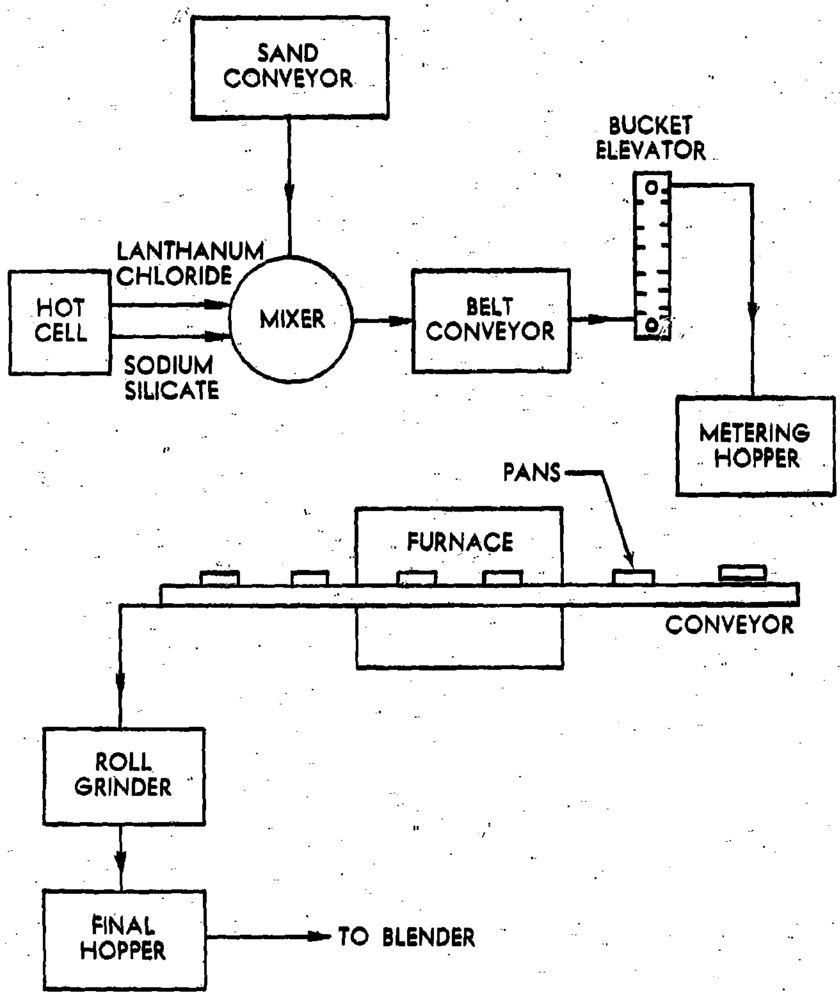


FIGURE A-2 FLOW DIAGRAM OF FALLOUT-SIMULANT PRODUCTION

A Wheelco controller, in conjunction with a shielded thermocouple set high on the firebox side wall, controls temperature by operating a solenoid valve in the fuel line. Firebox wall temperatures above 1500°F will reignite burners; below 1500°F the burners must be reignited manually.

The firebox is equipped with rails that mate to the two skid rails at each end along which the loaded pans ride. It will accommodate a maximum of seven pans at one time. The entire firebox is covered by a hood which is connected to a blower housed immediately under the roof of the building and vented through the roof.

A-1.4 Roll Grinder and Final Storage Hopper.

After the pans are removed from the furnace, they are cooled on the two skid rails and then dumped into a hopper by tipping the pans. The hopper is fitted with a gear motor-driven roll grinder which pulverizes the simulant and deposits it into a final storage hopper.

A-2. Tracer Processing.

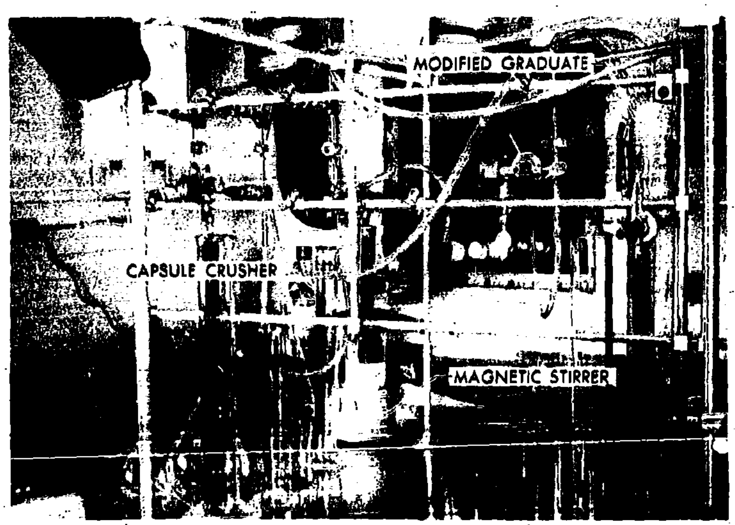
The lead cask containing the lanthanum was unloaded from the transport truck with a forklift and placed under an overhead crane that operates on a track leading directly into the hot cell (see figure A-3). The lead cask was attached to the hoist and transported into the hot cell where it was placed on a stack of concrete blocks to enable the manipulators to gain access to its interior. With Red Wing Model 8 manipulators, the lid was unbolted and removed from the cask and the hot cell was then closed and all interlock switches energized to prevent anyone from accidentally gaining access.

With the manipulators, a special tool was inserted into the cask to pick up the aluminum container and place it on a stainless-steel table. Once on the table, the aluminum-wire seal was broken with a knife, and the lanthanum capsule wrapped in aluminum foil was removed from the container. The capsule was then unwrapped, placed in a capsule crusher, and transferred to a 600-mℓ beaker containing 200 mℓ of 0.1 N HCl and a magnetic stirring rod. When the capsule was broken, the lanthanum oxide was dissolved in the acid. This solution and the pieces of quartz from the capsule were then poured into a 300-mℓ graduate. A small sample of from 0.1 to 0.5 cc was taken from the graduate and diluted with water in the ratio 1:1000 for assay purposes. When the dilution for assay was completed, a fritted glass filter was inserted into the 300-mℓ graduate, and the lanthanum solution was filtered and transferred to a 1000-mℓ graduate by means of a Gast-Vacuum pump.

The 1000-mℓ graduate had been fitted with a ground-glass joint into which was fitted a male joint consisting of one long glass tube and two short tubes. The long tube extended to the bottom of the graduate; one of the short tubes served as the vacuum-pressure line

(a) Operator Using Red Wing Model 8 Manipulators

(b) Interior Of Hot Cell



(c) Lanthanum Oxide In Solution With Hydrochloric Acid

FIGURE A-3 PREPARATION OF RADIOISOTOPE

and the other as an input tube for the lanthanum solution and the distilled water for rinsing purposes.

When the lanthanum was ready for spraying into the mixer, a pressure of 5 psi was applied to the graduate, forcing the lanthanum solution out into the tygon tubing, through the hot cell wall, and then into the spray lance at the mixer. The lanthanum solution was followed by two 200-mℓ rinses of distilled water to flush the lines.

A-3. <u>Sodium Silicate Processing</u>.

The binder used in the production of the fallout simulant was sodium silicate from the Fisher Scientific Company. The 40 degrees Baumé solution of sodium silicate was mixed with equal parts of water in a large glass jar and then poured into a section of pyrex pipe approximately 4 feet high and 6 inches in diameter. Attached to each end of this pipe was a metal plate fitted with a ½-inch globe valve. After the solution had been poured through the valve at the top (while the valve at the bottom was closed), the bottom valve was opened and air pressure of 16 psig was applied at the top valve to force the mixture out the bottom, through the tygon tubing, and into the spray lance. The sodium silicate solution was applied to the sand in the amount of 10 cc/lb of sand in the mixer. After application of the sodium silicate, one liter of distilled water was run through the lines to clean out the silicate and prevent clogging of the spray nozzle.

A-4. <u>Leaching Tests</u>.

Sand used for these tests was taken from the hopper containing the radioactive simulant, and was graded so that only that passing through a 350-micron sieve and retained on a 297-micron sieve was used. The soil, which was native to Camp McCoy and the immediate area, was graded and passed through a 44-micron sieve.

Three samples were prepared for testing - one after 24 hours, one after 48 hours, and one after 72 hours. Each sample was prepared by mixing one gram of sand and one gram of soil with a glass stirring rod and then adding and mixing in 0.25 cc of distilled water. Each sample was placed in a 15-cc vial, stoppered, and left to stand. After the required lapse of time, the sample was placed under heat lamps to dry. It was then placed in the Rotap and passed through an 88-micron sieve to effectively separate the soil from the sand. The soil and the sand were then placed in separate planchets and counted in an NMC Model PC-3A proportional counter for 5 minutes each. The results are shown in table A-1.

TABLE A-1

RESULTS OF LEACHING TESTS

Sample	Type of Sample	Counts/5 min	% Leached
24-hr	Native Soil (control)	8,630	
	Radioactive Sand (1 gm)	1,705,300	0.235
	Leached Soil (1 gm)	12,404	
	Background	318	
48-hr	Native Soil (control)	5,595	
	Radioactive Sand (1 gm)	1,142,080	0.26
	Leached Soil (1 gm)	8,649	
	Background	510	
72-hr	Native Soil (control)	3,884	
	Radioactive Sand (1 gm)	762,030	0.263
	Leached Soil (1 gm)	5,950	
	Background	345	

A-5. Rotap Analysis of Silica Sand.

The silica sand (Weldron No. 5030) used in the test series was sieved on a Model SS-8 Novo sieving machine to obtain a particle size range of 150-300 microns. The data shown in Table A-2 are averages of four Rotap analyses of 100-gm samples.

TABLE A-2

ROTAP ANALYSIS OF SIEVED SAND

Novo Screen Number	Screen Size (microns)	Amount Retained (gm)
42	350	12.03
48	297	30.38
100	149	56.10
150	105	1.21
170	88	0.10
325	44	0.18

A-6. Tracer Loss in Simulant Processing.

Loss of tracer material during six simulant processing runs varied between 9.2% and 34.0% (see Table A-3). This was attributed to activity left in the spray lines and on the walls of the mixer.

TABLE A-3

LOSS OF ACTIVITY DURING PROCESSING
(Material Balance)

Run No.	Amount of Sand	Hot Cell Total Activity	On-Line Sand Activity	Loss of Tracer Material
	(lb)	(curies)	(μc/gm)	(%)
1	500	17	50.7	20.0
2	250	18	125	20.0
3	250	5.3	47.2	30.0
4	250	21.7	192	23.0
5	250	14.6	143	34.0
6	500	49.6	202	9.2

Water rinses were not used in Run No. 1, so that some activity was left in the lines. Run No. 6 utilized two rinses, which, with the 500 pounds of sand, reduced the activity sprayed onto the walls of the mixer and thus the amount of activity lost.

APPENDIX B

HEALTH PHYSICS PROGRAM

The function of the Health Physicists assigned to the testing program was (1) to monitor all work involving radioactive materials; (2) to provide personnel monitoring service as required; (3) to study the levels of environmental radioactivity in and around the test areas; (4) to maintain radiological surveillance over the grounds, buildings, and equipment used in the program; and (5) to assist the operating personnel in the safe completion of the required tests.

B-1. Job Monitoring.

All activities involving the use of radioactive materials were continuously monitored by Health Physics personnel. These activities included the following:

Activity	Range of Dose Rates
Unloading of La^{140} shipments	40 mr/hr to 250 r/hr
Hot-cell operations (maximum outside the cell face)	- 185 mr/hr
Simulant plant operations	5 mr/hr to 35 mr/hr
Test-plot operations and logistics exercise	1 mr/hr to 2.5 r/hr

During the simulant-plant operations, air was sampled continuously both inside the building and at the exhaust stack. Airborne radioactivity levels inside the building were generally less than 10% of the MPC for insoluble lanthanum-140 in air. At the exhaust stack, a maximum of 14% of the MPC (air) was produced over a period of 168 hours. Respirators were worn whenever the continuous air monitor (CAM) reached the alarm level (~ 20,000 cpm), or when a rapidly rising concentration was observed. During a single simulant plant run, the dose to workers was generally in the order of 100 mr, but on one occasion reached 215 mr.

Typical Health Physics dose-rate measurements taken during the test-plot operations are shown in Table B-1. During a full day of test-plot operations, the dose accumulated by workers was, in general, less than 100 mr. Air samples taken downwind from the test plots during several spreading and decontamination operations indicated no airborne lanthanum-140 particles or dust. Even though no air hazard was evident,

TABLE B-1

TYPICAL HEALTH PHYSICS DOSE-RATE MEASUREMENTS
TAKEN DURING TEST-PLOT OPERATIONS
(mr/hr)

Contaminated Surface	Method of Decontamination	3 Feet Above Plot	Along Edge of Plot	At Operators Position (max)	Equipment After Test
Bare Asphalt	Mechanical Sweeper	~30	15 - 30	12	~1000 at hopper
Bare Concrete	Vacuum Sweeper	~30	15 - 30	60	500 in hopper
Bare Ground	Mechanical Sweeper	~30	20 - 25	50	1100 at hopper
	Vacuum Sweeper	~30	15 - 30	65	~1500 at hopper
	Rotary Broom	75 - 100	15 - 50	50	50 at broom
	Fire Hosing	~50	-	~50	-
Packed Snow	Vacuum Sweeper	50 - 90	20 - 50	40	~150 at hopper
	Motor Grader	~50	10 - 30	35	~1 on blade
Loose Snow	Rotary Snow Plow	50 - 70	-	~20	14 on runners 0.1-3.0 over rest

respirators were used by workers and observers in the immediate area of all operations that produced dust, blown snow, or vapor. With but one exception, these respirator filters did not become contaminated.

In order to establish certain areas as controlled-access radiation areas, rope fences, improvised sign posts, and sawhorse-type barricades were placed around the test areas and on certain access roads to the test areas. These fences and barricades were posted with CAUTION: RADIATION AREA signs bearing the radiation symbol. Information and instructions concerning these areas were published in the Camp McCoy bulletin.

B-2. Personnel Monitoring.

Owing to the nature of the work, radioactive contamination of clothing, and in some cases men, was often encountered. While this contamination was sometimes as high as several millirem per hour on boots and outer clothing, the physical form of the contaminant (large sand particles) rendered it easily removable by brushing or washing with plain water. In only a few instances - when the contamination had become embedded in grease or oil on coats, coveralls, or gloves - was it necessary to store the contaminated items.

Radiation exposures and possible uptake of radioactive material by personnel were monitored through the use of film badges, pocket dosimeters, and routine radiometric urinanalysis. Although pocket dosimeters are not entirely reliable or precise, they can be used as a quick indicator of accumulated exposure so that total doses can be estimated and controlled. The dosimeters used at Camp McCoy consistently indicated a dose 20% lower than that calculated from film-badge data, so that reliable estimation and control of total doses was possible. Records of accumulated exposures were based on film-badge data alone.

Personnel exposures accumulated by the twenty permanently assigned people (GD/FW employees, NDL observers, etc.) ranged from 0 mr to 1451 mr, the average exposure being 650 mr. These totals were accumulated during the entire period of work with radioactive material, i.e., from 16 December 1961 through 16 February 1962. Past exposure histories of all the permanently assigned personnel showed that allowable exposures could have been as high as 3000 mr per person per calendar quarter.

Pre-operational urine samples from the permanently assigned personnel ranged from 0 to 230 disintegrations per minute per liter (β,γ activity), with an average of 125 dpm/liter; post-operational urine samples ranged from 0 to 440 dpm/liter, with an average of 166 dpm/liter.

Personnel monitoring service for the Army and Navy personnel involved in the decontamination of the logistics complex consisted of the use and analysis of GD/FW film badges and pocket dosimeters, U. S. Army Signal Corps film badges, and pre- and post-operational urine samples. The average exposure to these people was 56 mr. The maximum dose was 335 mr and was accumulated by a man who assisted and observed the simulant-plant run prior to the logistics exercise. This dose was excluded from the average. One other film badge was omitted from the average because of a processing error. Pre-operational urine samples ranged from 0 to 330 dpm/liter, with an average of 148 dpm/liter. Post-operational urine samples ranged from 0 to 400 dpm/liter, with an average of 108 dpm/liter.

B-3. Environmental Monitoring.

Samples of soil, sub-soil, vegetation, water, and ice or snow were collected once each month at various locations in and around the test area. The on- and off-site sampling locations are shown in figures B-1 and B-2, and were chosen with regard to population density and prevailing winds. The data recorded from analysis of the samples collected are presented in figures B-3 and tables B-2 through B-6.

Environmental air samples were collected once each month at Tomah, Kendall, Sparta, and Black River Falls, Wisconsin, by local authorities furnished with Staplex Hi Vol Air Sampler having GD/FW 7x9-inch filter heads. Particulate matter was collected from 1000 to 2000 cubic meters of air per sample during a 24-hour run at each station. The maximum concentration detected was about 10^{-12} μc/cc of unknown emitters. This level is comparable to levels of airborne contamination in other parts of the country and is attributable to Russian weapons test debris. Decay studies (see figure B-4) indicate half-lives of approximately 60 days. None of the environmental samples showed the presence of lanthanum-140.

B-4. Miscellaneous Activities.

Health Physics personnel acted as escorts for transfer of activated lanthanum from Argonne National Laboratory to Camp McCoy on three occasions.

Ten cesium-137 sources of 500 mc each were checked when they arrived at Camp McCoy and found to be highly contaminated. A five-day leak test performed on them indicated that most of the sources were leaking. They were, therefore, repacked in their original shipping container and returned to the manufacturer. A letter reporting the condition of the sources was sent to the appropriate offices of the USAEC pursuant to requirements of 10 CFR 20 (Code of Federal Regulations) and GD/FW's isotope license. Building areas, tools, and equipment used in testing these sources were surveyed. All contamination was removed

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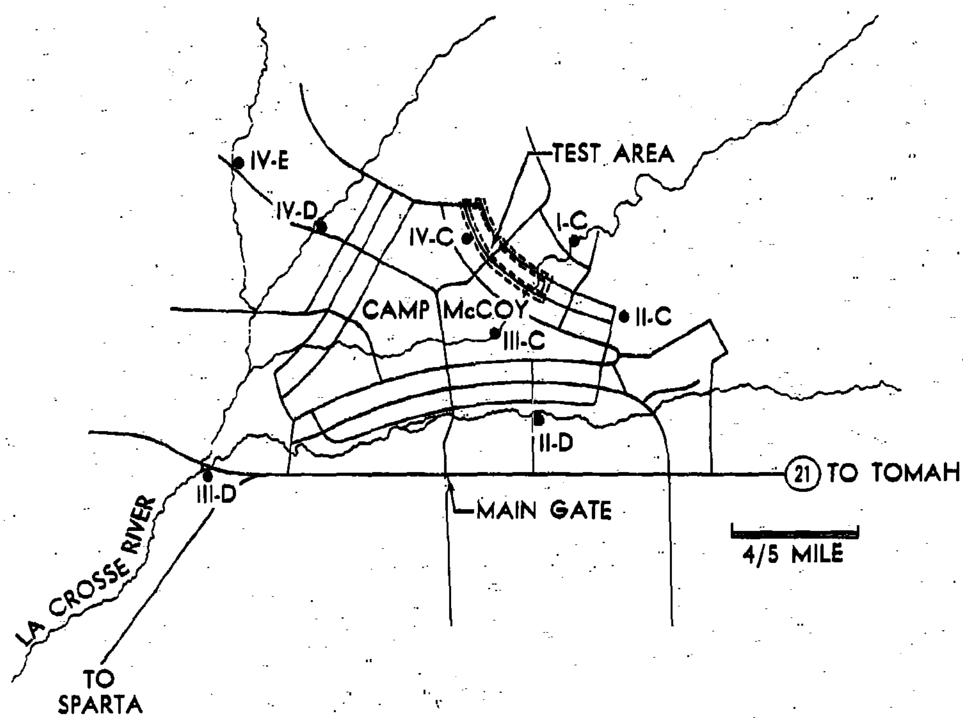

STATION	SAMPLE TYPES
I-C	SOIL, SUB-SOIL, WATER, VEGETATION
II-C	SOIL, SUB-SOIL, VEGETATION
II-D	WATER
III-C	SOIL, SUB-SOIL, WATER
III-D	WATER, VEGETATION
IV-C	SOIL, SUB-SOIL, VEGETATION
IV-D	WATER
IV-E	WATER, SOIL

FIGURE B-1 ON-SITE ENVIRONMENTAL SAMPLING LOCATIONS

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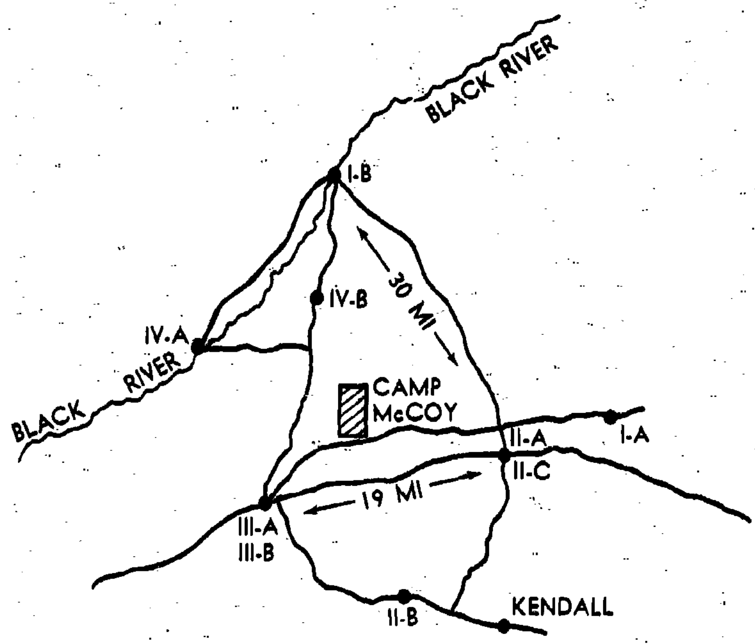

STATION	LOCATION	SAMPLE TYPES
I-A	WYEVILLE	CREEK WATER, SOIL, SUB-SOIL, VEGETATION
I-B	BLACK RIVER FALLS	RIVER WATER, SOIL, SUB-SOIL, VEGETATION, AIR
II-A	TOMAH LAKE	LAKE WATER, SOIL, SUB-SOIL, VEGETATION
II-B	WILTON	CREEK WATER, SOIL, SUB-SOIL, VEGETATION
II-C	TOMAH	DRINKING WATER, AIR
III-A	SPARTA LAKE	LAKE WATER, SOIL, SUB-SOIL, VEGETATION
III-B	SPARTA	DRINKING WATER, AIR
IV-A	MELROSE	RIVER WATER, SOIL, SUB-SOIL, VEGETATION
IV-B	CATARACT	CREEK WATER, SOIL, SUB-SOIL, VEGETATION
	KENDALL	AIR

FIGURE B-2 OFF-SITE ENVIRONMENTAL SAMPLING LOCATIONS

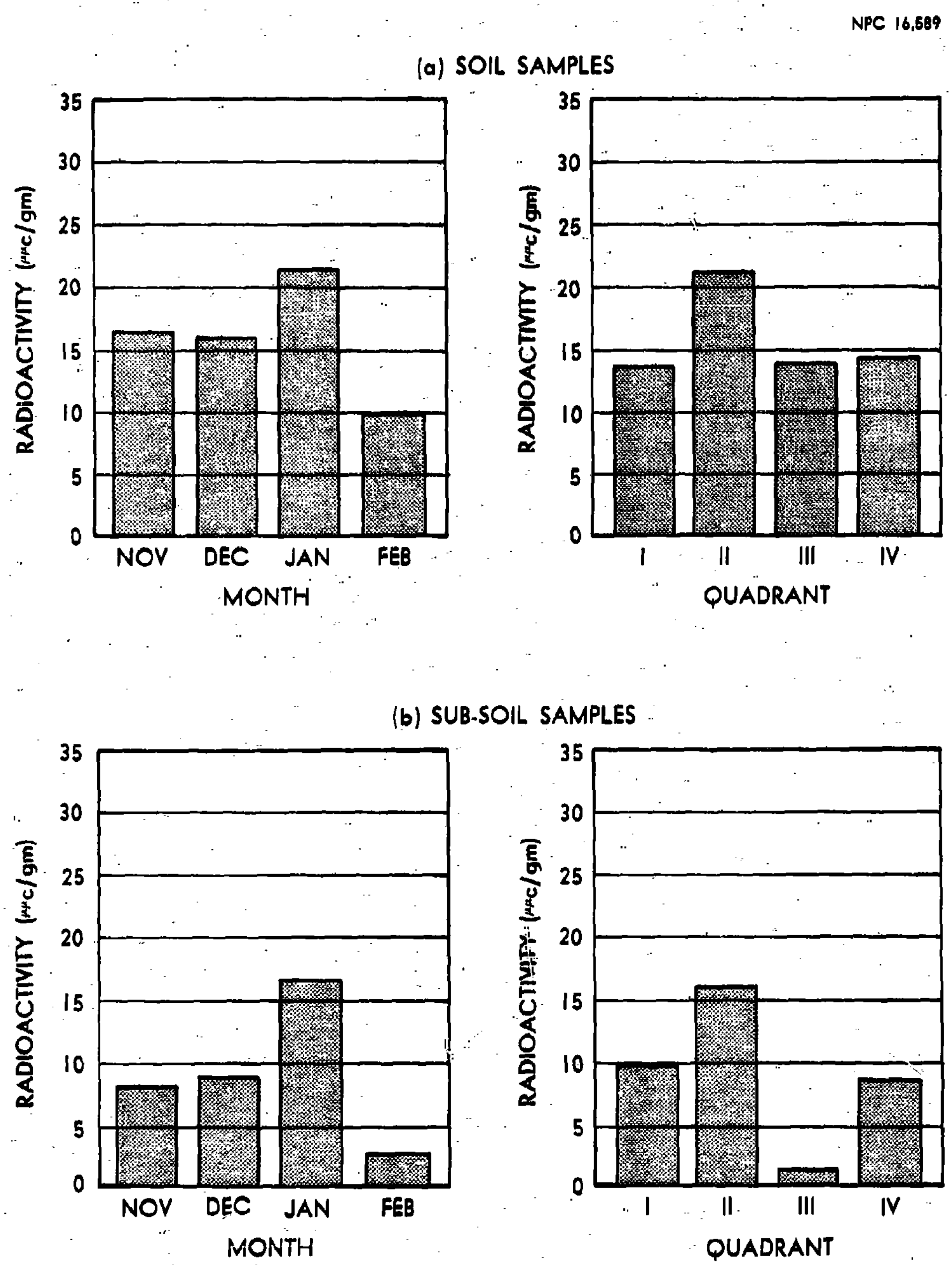

FIGURE B-3 RADIOACTIVITY OF ENVIRONMENTAL SAMPLES

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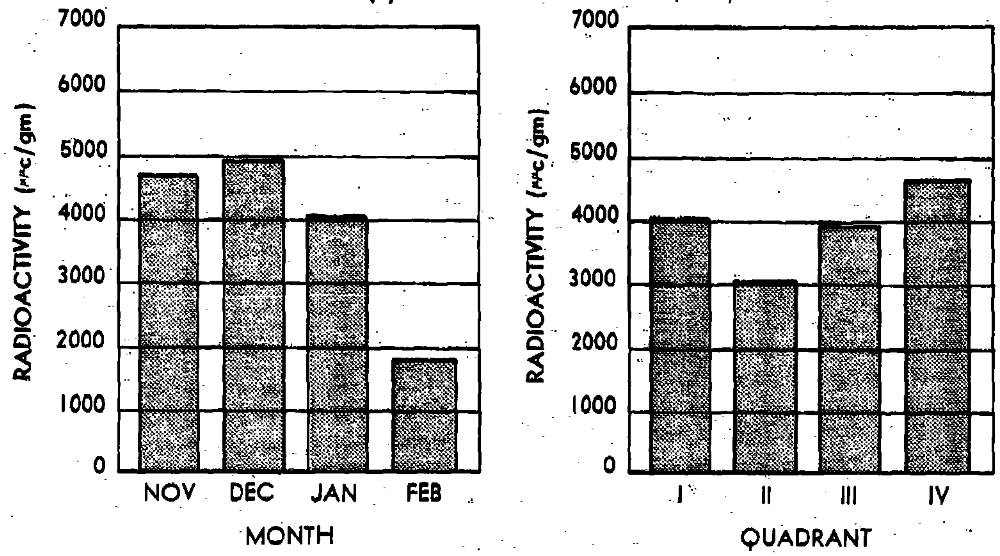
(c) VEGETATION SAMPLES (ASH)



(d) WATER SAMPLES

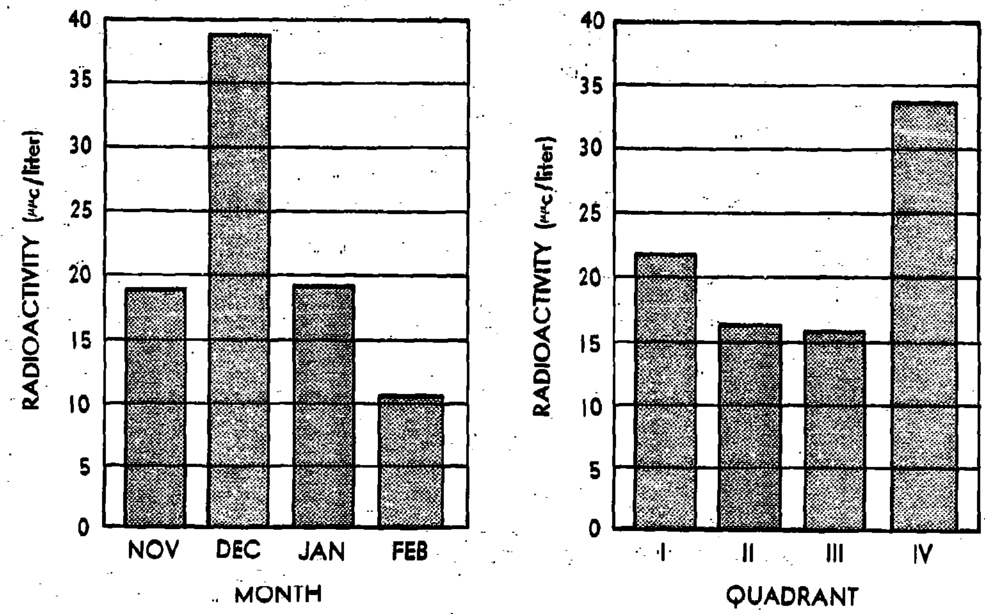


FIGURE B-3 (CONT'D)

TABLE B-2

RADIOACTIVE CONTENT OF SOIL SAMPLES
($\mu\mu c/gm$)

Station	November	December	January	February
I-A	34.74 ± 2.95	7.37 ± 5.76	7.37 ± 5.88	0 ± 1.94
I-B	8.85 ± 2.55	45.50 ± 6.51	16.08 ± 5.95	8.33 ± 2.26
I-C	9.54 ± 2.51	8.71 ± 5.16	12.70 ± 5.98	4.76 ± 2.58
II-A	44.96 ± 3.06	26.80 ± 6.16	- -	18.2 ± 2.54
II-B	33.89 ± 2.79	21.40 ± 5.70	26.10 ± 6.29	12.7 ± 2.52
II-C	14.52 ± 2.18	0 ± 7.14	22.10 ± 6.07	10.2 ± 2.44
III-A	8.85 ± 2.46	- -	50.30 ± 6.69	15.4 ± 2.52
III-B	4.62 ± 2.22	- -	- -	- -
III-C	10.90 ± 2.53	13.40 ± 5.41	0 ± 5.65	3.4 ± 2.44
IV-A	11.76 ± 2.52	5.36 ± 5.69	38.90 ± 6.50	- -
IV-B	17.29 ± 2.51	6.05 ± 5.14	14.10 ± 6.03	5.45 ± 2.57
IV-C	2.72 ± 2.43	10.05 ± 5.43	17.42 ± 6.09	18.1 ± 2.57
IV-E	0.68 ± 2.29	32.80 ± 5.87	- -	- -
Average	15.64 ± 2.54	16.13 ± 5.84	20.50 ± 6.12	9.66 ± 2.44

TABLE B-3

RADIOACTIVE CONTENT OF SUB-SOIL SAMPLES
($\mu\mu c/gm$)

Station	November	December	January	February
I-A	36.78 ± 2.99	2.64 ± 5.18	0 ± 5.61	4.08 ± 2.44
I-B	1.50 ± 2.48	24.10 ± 5.74	28.8 ± 6.22	4.05 ± 2.34
I-C	4.84 ± 2.44	0 ± 4.92	8.71 ± 5.92	0 ± 2.54
II-A	16.09 ± 2.53	12.70 ± 5.46	- -	- -
II-B	27.44 ± 2.72	36.20 ± 6.00	21.44 ± 6.17	3.37 ± 2.36
II-C	0 ± 2.20	3.34 ± 5.25	42.20 ± 6.49	3.46 ± 2.42
III-A	2.04 ± 2.43	- -	6.03 ± 5.64	0 ± 2.51
III-B	0 ± 2.43	- -	- -	- -
III-C	0 ± 2.33	0 ± 5.09	0 ± 5.70	1.36 ± 2.24
IV-A	6.04 ± 2.37	16.10 ± 5.56	22.1 ± 6.19	3.74 ± 1.90
IV-B	0 ± 2.20	12.70 ± 5.46	14.1 ± 6.03	4.71 ± 2.35
IV-C	0 ± 2.19	2.64 ± 5.18	- -	0 ± 2.51
Average	7.89 ± 2.44	11.04 ± 5.39	15.93 ± 5.70	2.48 ± 2.36

TABLE B-4

RADIOACTIVE CONTENT OF VEGETATION SAMPLES
[μμc/gm(ash)]

Station	November	December	January	February
I-A	7062.6 ± 55.9	3513 ± 78	6431 ± 95	3172 ± 44
I-B	4519.6 ± 33.4	7260 ± 101	1754 ± 56	2665 ± 34
I-C	2862.6 ± 27.3	3683 ± 72	2318 ± 62	2232 ± 32
II-A	5057.7 ± 34.2	4690 ± 105	- -	- -
II-B	3326.8 ± 37.6	3860 ± 75	2734 ± 66	1219 ± 19
II-C	4666.6 ± 34.8	3010 ± 68	2288 ± 61	1079 ± 35
III-A	2115.3 ± 33.6	4460 ± 119	1311 ± 50	66095 ± 1256*
III-B	2898.2 ± 39.4	- -	- -	- -
III-C	5359.0 ± 38.3	- -	2842 ± 67	1089 ± 14
III-D	6813.0 ± 60.7	9310 ± 130	4398 ± 80	1565 ± 22
IV-A	3851.3 ± 29.9	1410 ± 162	1670 ± 54	4405 ± 57
IV-B	3548.3 ± 26.5	8100 ± 58	17993 ± 155	540 ± 11
IV-C	8028.6 ± 58.4	2770 ± 70	1444 ± 52	643 ± 12
Average	4623.8 ± 39.2	4733 ± 99	4108 ± 78	1861 ± 31

TABLE B-5

RADIOACTIVE CONTENT OF WATER SAMPLES
(μμc/liter)

Station	November	December	January	February
I-A	11.26 ± 17.44	0 ± 40.08	- - *	- - *
I-B	51.53 ± 17.58	13.85 ± 41.56	6.94 ± 41.7	26.62 ± 18.06
I-C	37.77 ± 17.97	0 ± 41.50	28.15 ± 41.56	0 ± 17.15
II-A	26.53 ± 17.29	- - *	- -	- - *
II-B	4.14 ± 18.08	112.7 ± 39.1	- - *	- - *
II-C	0 ± 17.12	0 ± 36.24	- -	16.53 ± 18.22
II-D	0 ± 17.15	18.0 ± 42.0	0 ± 40.70	3.36 ± 16.97
III-A	0 ± 16.73	21.78 ± 41.45	- - *	- - *
III-B	3.58 ± 16.61	0 ± 42.5	0 ± 38.65	8.27 ± 17.75
III-C	7.26 ± 17.55	42.7 ± 40.5	33.78 ± 40.90	3.60 ± 19.60
III-D	20.92 ± 15.17	20.3 ± 39.0	3.44 ± 41.13	39.32 ± 17.20
IV-A	57.77 ± 17.94	- - *	- - *	- - *
IV-B	3.42 ± 16.34	- - *	- - *	- - *
IV-D	6.82 ± 16.34	107.66 ± 39.27	46.24 ± 42.22	0 ± 17.52
IV-E	10.25 ± 15.30	63.1 ± 48.4	10.47 ± 41.74	0 ± 20.17
Average	16.08 ± 16.97	33.34 ± 41.07	16.13 ± 41.1	10.86 ± 18.11

*See Table B-6

TABLE B-6

RADIOACTIVE CONTENT OF SNOW AND ICE SAMPLES
(μμc/liter)

Station	November	December	January	February
I-A	- -	- -	1234.23 ± 57.9	152.96 ± 159.69
II-A	- -	375.0 ± 47.25	- -	208.03 ± 67.16
II-B	- -	- -	4101.35 ± 84.65	50632.43 ± 753.66
III-A	- -	- -	2387.39 ± 70.37	1044.14 ± 231.73
IV-A	- -	1087.41 ± 49.05	1273.38 ± 58.40	2095.49 ± 253.18
IV-B	- -	207.2 ± 42.2	3207.20 ± 94.00	60.95 ± 89.83

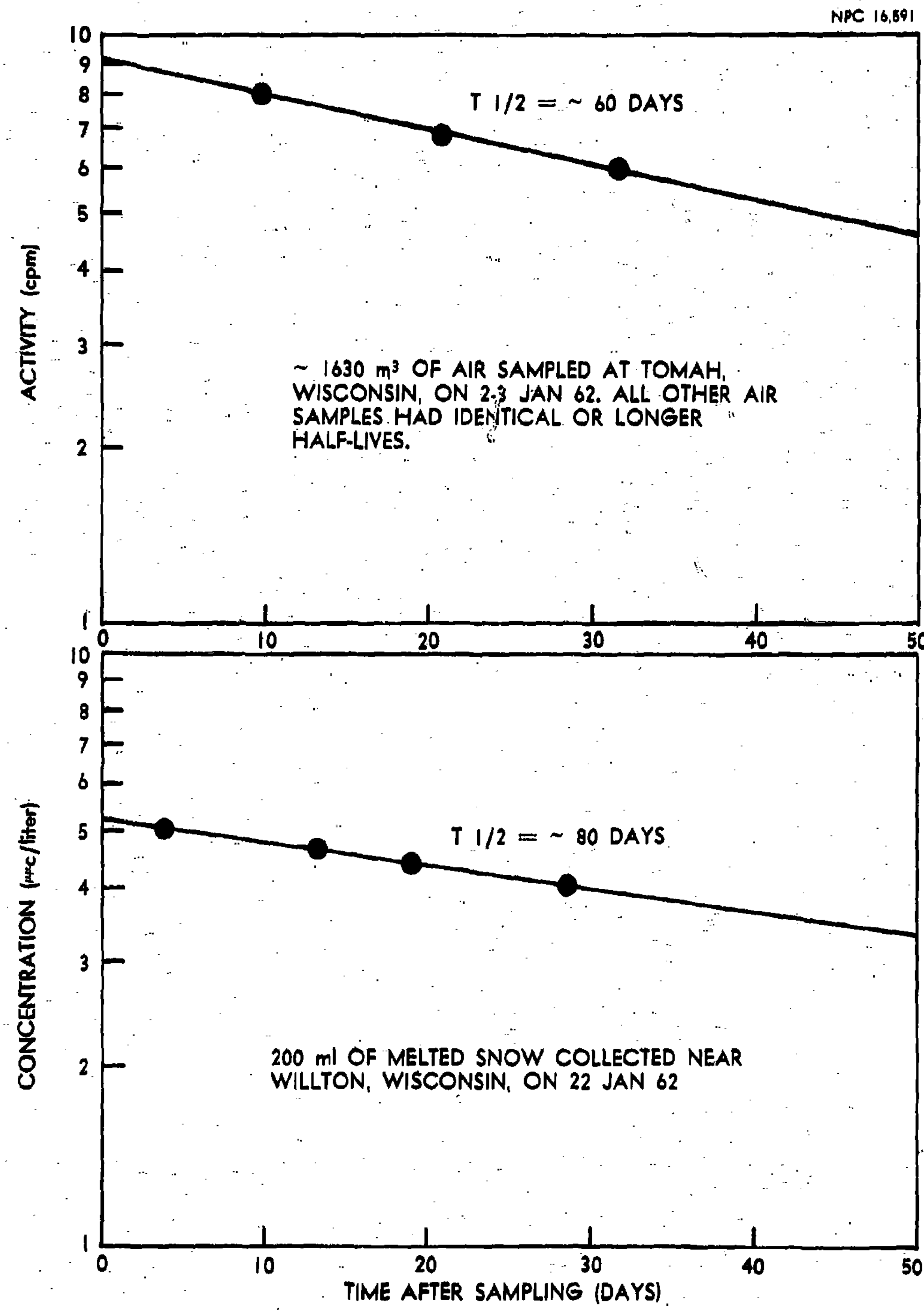


FIGURE B-4 DECAY OF RADIOACTIVITY IN ENVIRONMENTAL SAMPLES

from the building areas (floors, etc.), and tools and waste were either decontaminated or stored for future disposal.

B-5. Release of Areas and Equipment.

At various intervals after the conclusion of the test program, samples were taken from the piles of debris accumulated during the decontamination of test plots and complexes. Radiation surveys were made and smear samples were taken on all contaminated or suspect machinery, equipment, and buildings.

While decontamination debris analyzed early in February contained thousands of disintegrations per minute per gram, by the end of February similar samples contained on the order of one disintegration per minute per gram.

The contamination of heavy equipment (trucks, graders, tractors, etc.), which read as high as 4 mr/hr following an unsuccessful decontamination attempt early in February, was reduced to undetectable dose rates by February 22nd. All heavy equipment was returned uncontaminated to the equipment pools at Camp McCoy.

APPENDIX C

RADIATION DETECTION EQUIPMENT

Three instruments were used to measure the radioactive simulant: the Automatic Detection System, designed and built at GD/FW; a Model 2586 Cutie Pie, manufactured by Nuclear-Chicago Corporation; and a Model E-200A Geiger-Mueller tube, manufactured by the Eberline Instrument Company. The Automatic Detection System was used to make continuous scans at 10-ft intervals across the test plots. The other two instruments are hand-portable and were used in all other tests.

C-1 Automatic Detection System.

The Automatic Detection System, shown in figure II-5, consisted of an anthracene scintillation detector (ASD) and a traversing mechanism that enabled the detector to make a continuous scan while moving across the test plot at a given height above the surface. Figure C-1 is a reproduction of a scan made on the X-Y recorder which illustrates the high degree of reproducibility of the system.

The instrumentation for the Automatic Detection System, or scanner, is shown schematically in figure C-2. A heated trailer was provided to protect the high-voltage power supply, micromicroammeter, and X-Y recorder from the cold weather and to facilitate transportation of these components from one test plot to another.

C-1.1 Anthracene Scintillation Detector.

The ASD was designed and built at GD/FW. It is made up of an anthracene crystal 2 inches in diameter by 2 inches thick, a General Electric 5819 photomultiplier tube, and the necessary components to produce a current. A lead collimator, also made at GD/FW, was placed over the crystal on the ASD so that with the detector at a height of 12 inches it would be sensitive to an area on the ground 12 inches in diameter.

The energy response of anthracene to gamma rays with energies greater than 0.2 Mev approximates that of tissue. The photons produced in the crystal are transformed into electrical pulses by the photomultiplier tube. These pulses are then integrated by an RC circuit and the resulting current measured by a micromicroammeter.

C-1.2 Micromicroammeter.

The overall range of the micromicroammeter (Convair Model MMA-1) is 10×10^{-6} to 10×10^{-11} amperes. In the range of from 10×10^{-6} through 3×10^{-7}, the accuracy is 2%; in the range of from

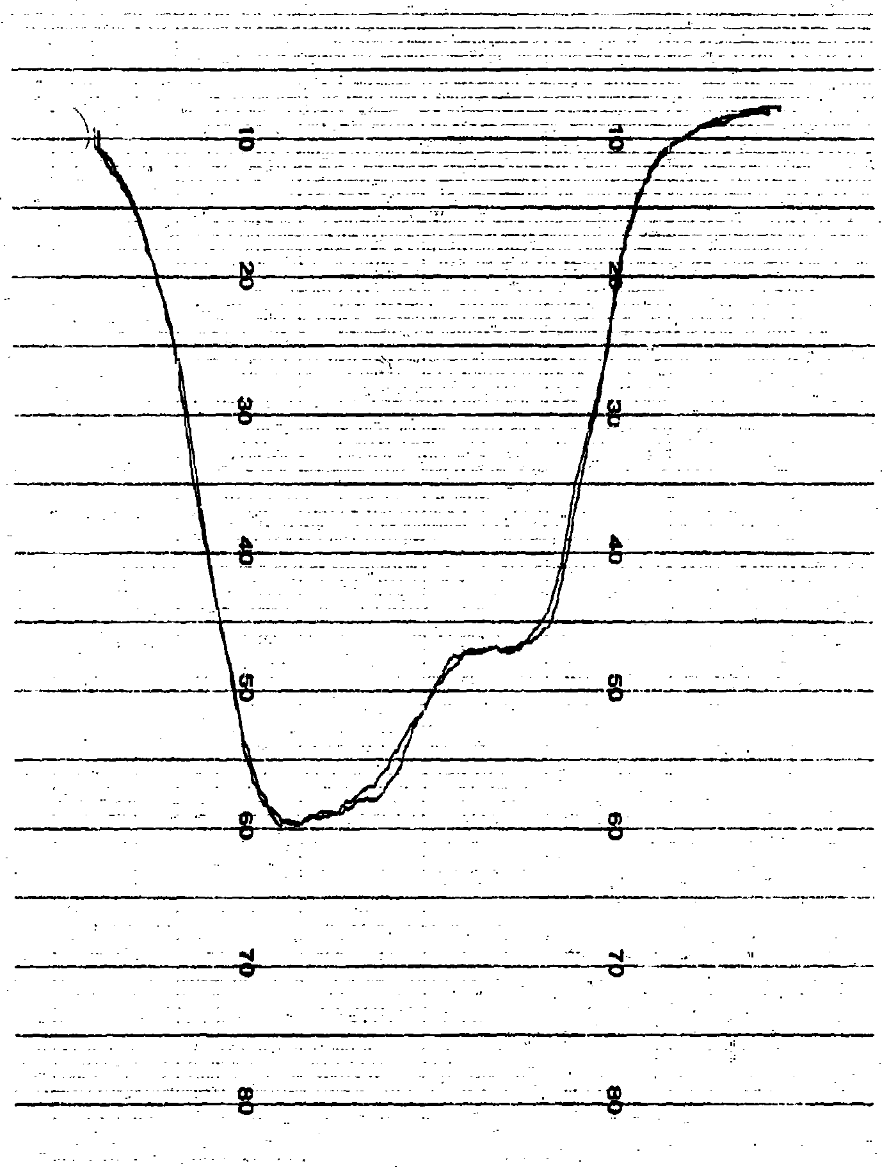


FIGURE C-1 RECORDING SHOWING REPRODUCIBILITY OF THE SCANNER

10×10^{-8} through 10×10^{-11}, the accuracy is 4%. The input impedance is controlled by negative feedback from the output, so that the voltage drop across the input terminals is less than 5 millivolts for full-scale meter deflection.

The zero drift is less than 2% of full scale in an 8-hour period when little or no warm-up time is allowed. After a 2-hour warm-up, the drift is one-half to one-fourth of this amount.

C-1.3 X-Y Recorder.

The output of the micromicroammeter is fed to the x-axis of a Sylvania X-Y Recorder, type B-281, which is a flat-bed model designed for high-speed analog recording and plotting on graph paper. The sensitivity ranges from 0.1 to 10 volts/inch, with a static accuracy of 0.15% full scale and a dynamic accuracy of 0.2% at 6 inches/second. The pen speed (y-axis) of the recorder is 20 inches/second and the carriage speed (x-axis) is 25 inches/second. The recording area is 10 by 15 inches.

C-1.4 Potentiometer and Power Pack.

A 10-turn, 2000-ohm potentiometer with a linearity of 0.1% was used to drive the x-axis of the recorder. The shaft of the potentiometer was coupled to the traversing mechanism in such a way that the output voltage from the potentiometer to the recorder was directly proportional to the distance traversed.

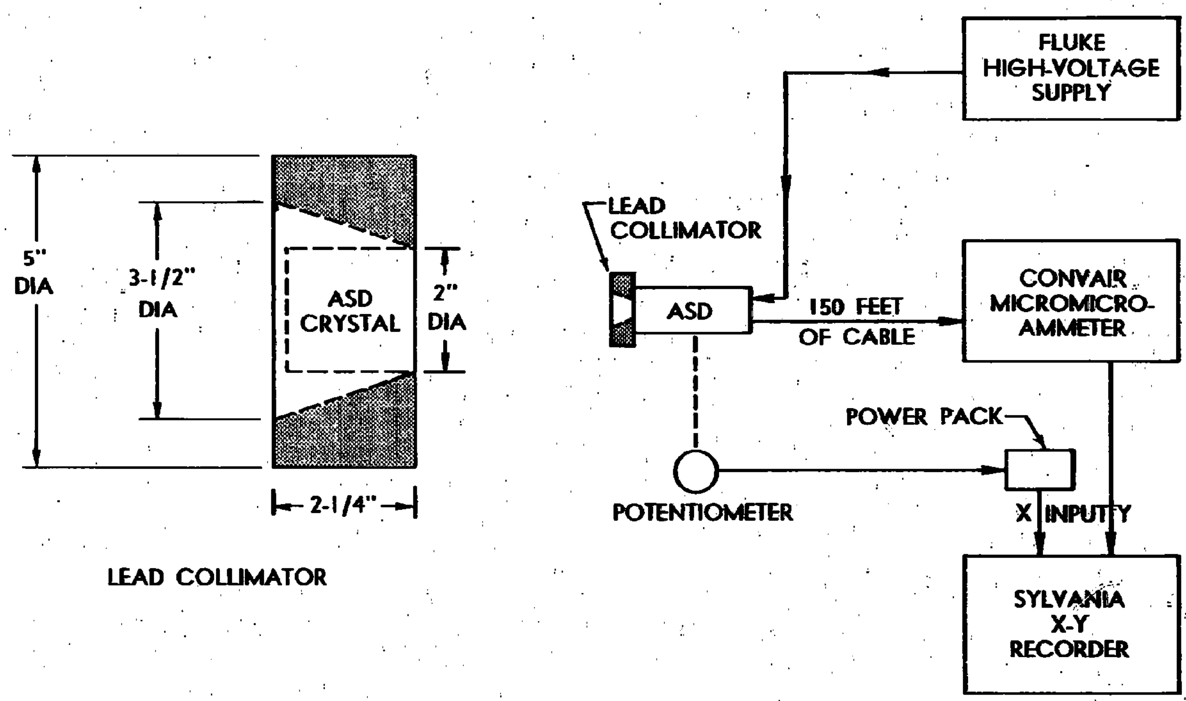
C-1.5 Traversing Mechanism.

A traversing mechanism for holding the anthracene scintillation detector (ASD), collimator, and potentiometer was designed and built at GD/FW. This apparatus, consisting of a triangular truss supported by an A frame on either end, is approximately 21 feet in length and 6 feet in height. A carrier, which holds the ASD, collimator, and detector cables, travels the 20 feet on the underside of the truss and is operated by an endless cable on a drum from one end of the frame. A source made of two Co^{60} foils was used to standardize the ASD.

The detector high-voltage (RG-59 coaxial) and signal-current (Microdot low-noise coaxial) cables were restricted to a length of under 200 feet because of the micromicroammeter.

C-2 Cutie Pie.

A Nuclear-Chicago Model 2586 Cutie Pie survey meter designed for measurement of beta and gamma radiation was used in the logistics exercise. This portable, battery-powered instrument is entirely self-contained. Its plug-in ionization chamber has a sealed section that contains the sensitive electrometer circuit. The cylindrical ionization



NPC 16,586

FIGURE C-2 SCHEMATIC DIAGRAM OF INSTRUMENTATION FOR SCANNER

chamber has a volume of 500 cm^3 and is equipped with an end-window having a density of less than 1 mg/cm^2. This window allows entrance of beta particles. A slip-on plastic window shield is supplied with the instrument and is used when measuring gamma radiation.

The meter has three linear full-scale ranges - 25, 250, and 2500 mr/hr - and a calibration accuracy of ±10% of full scale on all ranges. The time-constant response is less than two seconds on all ranges. Instrument warm-up time is one minute for a meter indication within 2% of equilibrium value. Zero drift is less than 5% of full scale for eight hours of operation after the initial warm-up period.

C-3 Geiger-Mueller Survey Instrument.

An Eberline Instrument Company Model E-200A Geiger-Mueller tube survey instrument was also used in the logistics exercise. This portable, battery-powered instrument is entirely self-contained. The G-M tube is mounted in a probe that has a movable shield for beta or gamma radiation measurement. The instrument has six full-scale ranges: 0.1, 1.0, 10.0, 0.2, 2.0, and 20.0 mr/hr. The time constant response is adjustable by means of a meter response control. The calibration accuracy is ±10% of full scale on all ranges.

APPENDIX D

METEOROLOGICAL PROCEDURE AND DATA

A resume of meteorological conditions affecting the test operations during December of 1961 and January and February of 1962 is given below:

Period	Temperature (°F)			Snow (in.)		Wind
	Min	Max	Mean	Snow-Fall	Mean Depth	
December 3-31	-22	59	17	8	6.0	Light
January 1-31	-24	40	11	1.5	5.3	and
February 1-12	-13	44	15	0.8	4.5	Variable

The mean monthly temperatures were six to nine degrees below normal for the period indicated and precipitation was several inches below normal. At La Crosse, 45 miles to the west, the snowfall was the second least amount (1.9 in.) on record for January.

Winds at the test site were generally light and variable, the velocity rarely exceeding 15 mph. During a calm or a light-wind condition, there was nocturnal drainage of cold air from the surrounding hills to the floor of the Camp McCoy basin. This caused pockets of relatively colder air in low-lying areas. As much as a 13° temperature differential was observed between measurements taken simultaneously at two different locations within the reservation.

Camp temperatures were taken at Fire Station No. 1, about one mile from the test site. Continuous recordings were made by a Taylor recorder, which had been checked and calibrated by the U. S. Weather Bureau. The sensor was positioned near the eave, where it was shielded from the direct rays of the sun; however, it was apparent that when the air was calm, heat radiating from the warm building contributed some error to the true air temperature readings. A comparison of air temperatures measured at the Fire Station and at the Test Headquarters (Bldg. 230) by a hygrothermograph is shown in figure D-1. Daily temperatures for the test period are given in figures D-2 and D-3.

It was observed that frequently the temperature of the test surface (snow, bare ground, concrete, etc.) was different from that of the air about four feet above the ground. This "discrepancy" was due to the difference between the heat capacity of air and that of the solid surface, as well as to warm or cold air advection. A measurement of the temperatures of surface materials and air under various conditions over a period of time was made by utilizing copper-constantan thermocouples as temperature sensors at various locations and a Brown recorder to provide a continuous record of data. Temperatures obtained in this way are tabulated in table D-1 for a 24-hour period and plotted in figure D-4 for a 48-hour period.

The temperature profiles and tabular data show the importance of properly describing the method of temperature measurement; wide variations of readings may occur, depending on environmental conditions and the location of the sensor.

During test operations, the surface temperatures were obtained by placing two thermometers face up on the snow (ground or roof). Air temperatures were measured by thermometers mounted on the scanner traverse frame. The air temperature measurements were compared with those recorded at Fire Station No. 1, the USWB official camp temperature. Except for differences due to insolation or shadow effects, the readings were usually within two or three degrees.

Wind velocity measurements were made with an anemometer mounted atop building 645 with readout on a White windspeed indicator. Snow density measurements (table D-2) were made by obtaining a sample in a graduated plastic cylinder and weighing it.

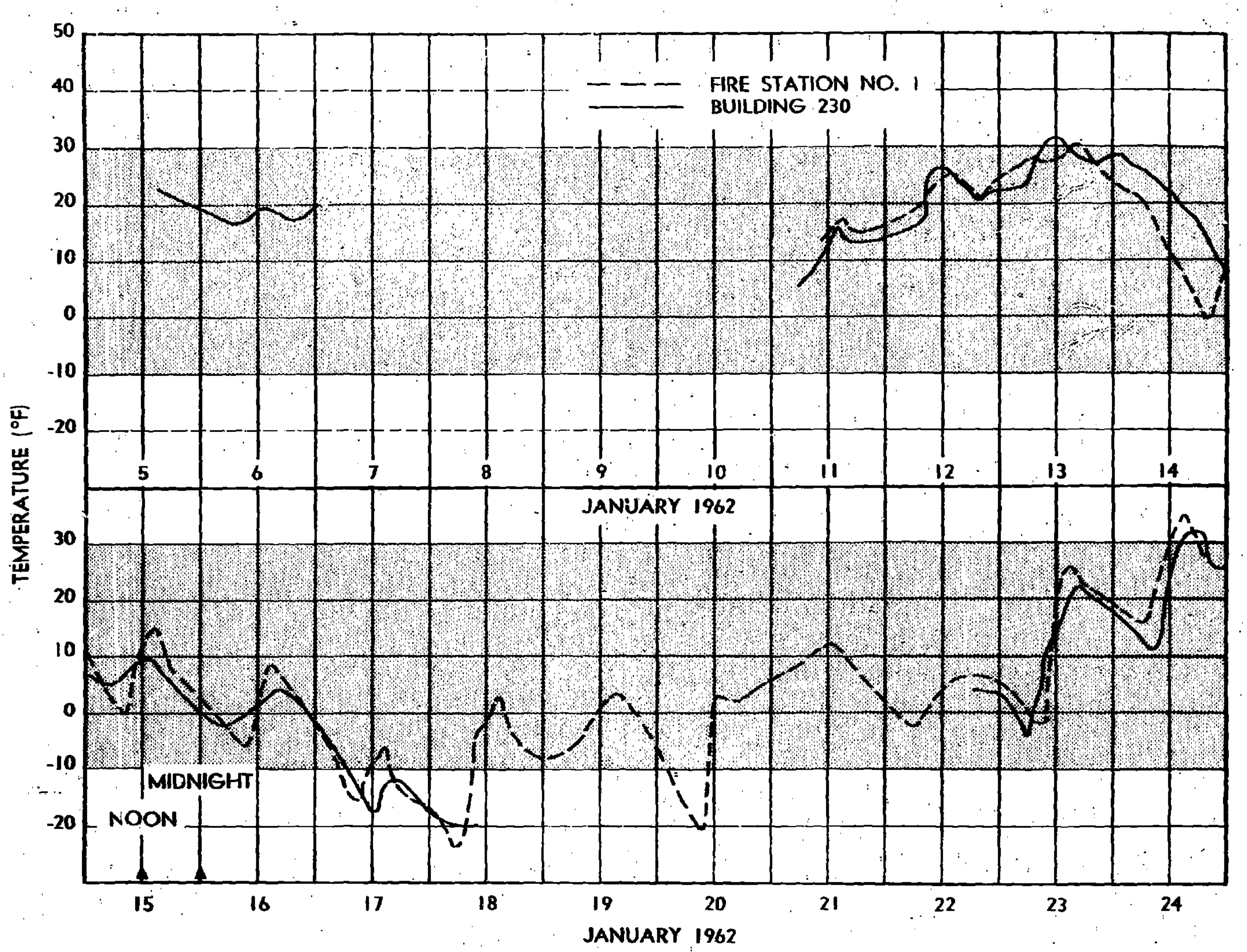


FIGURE D-1 AIR TEMPERATURES AT FIRE STATION NO. 1 AND BUILDING 230

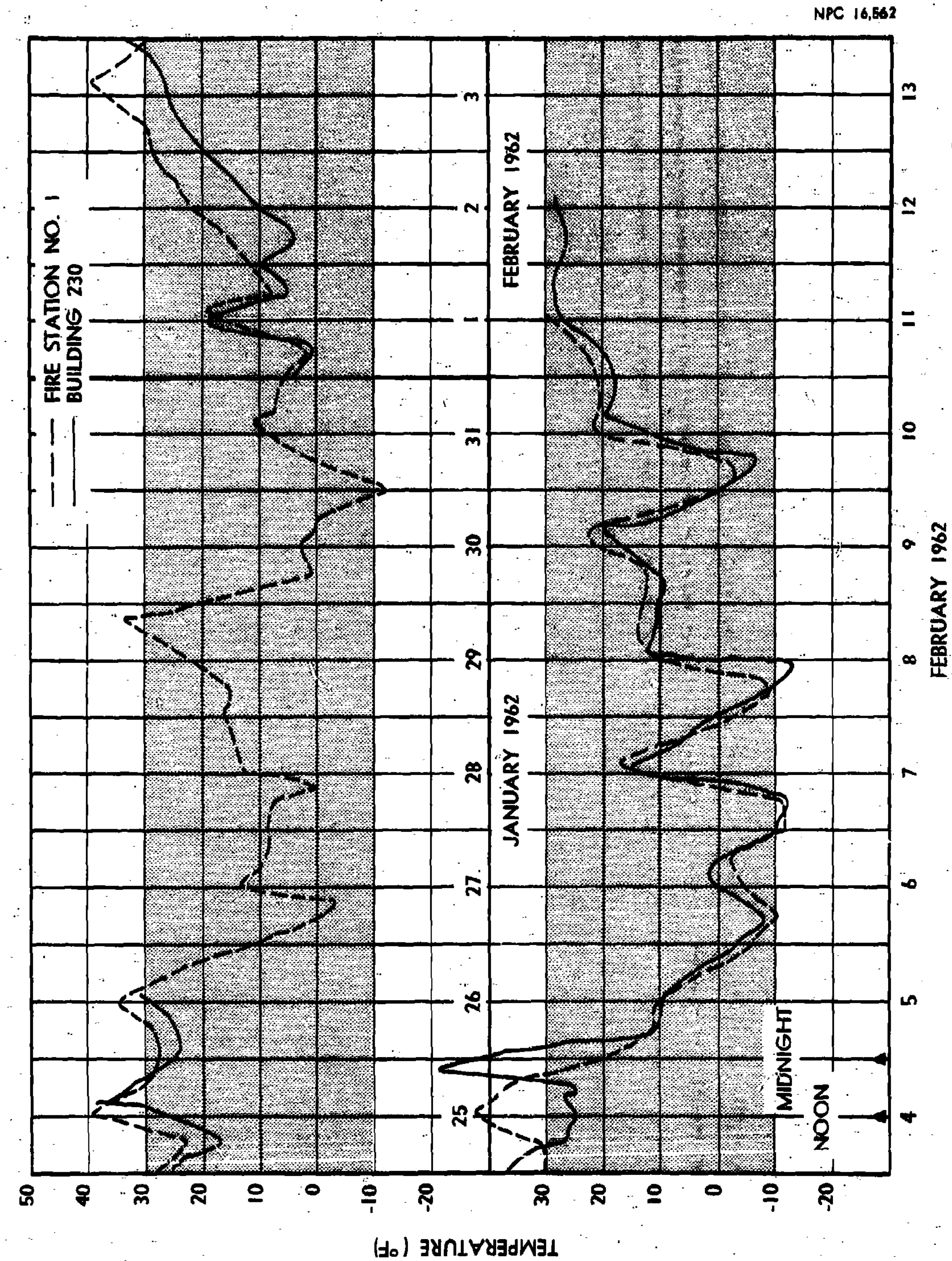


FIGURE D-1 (Cont'd)

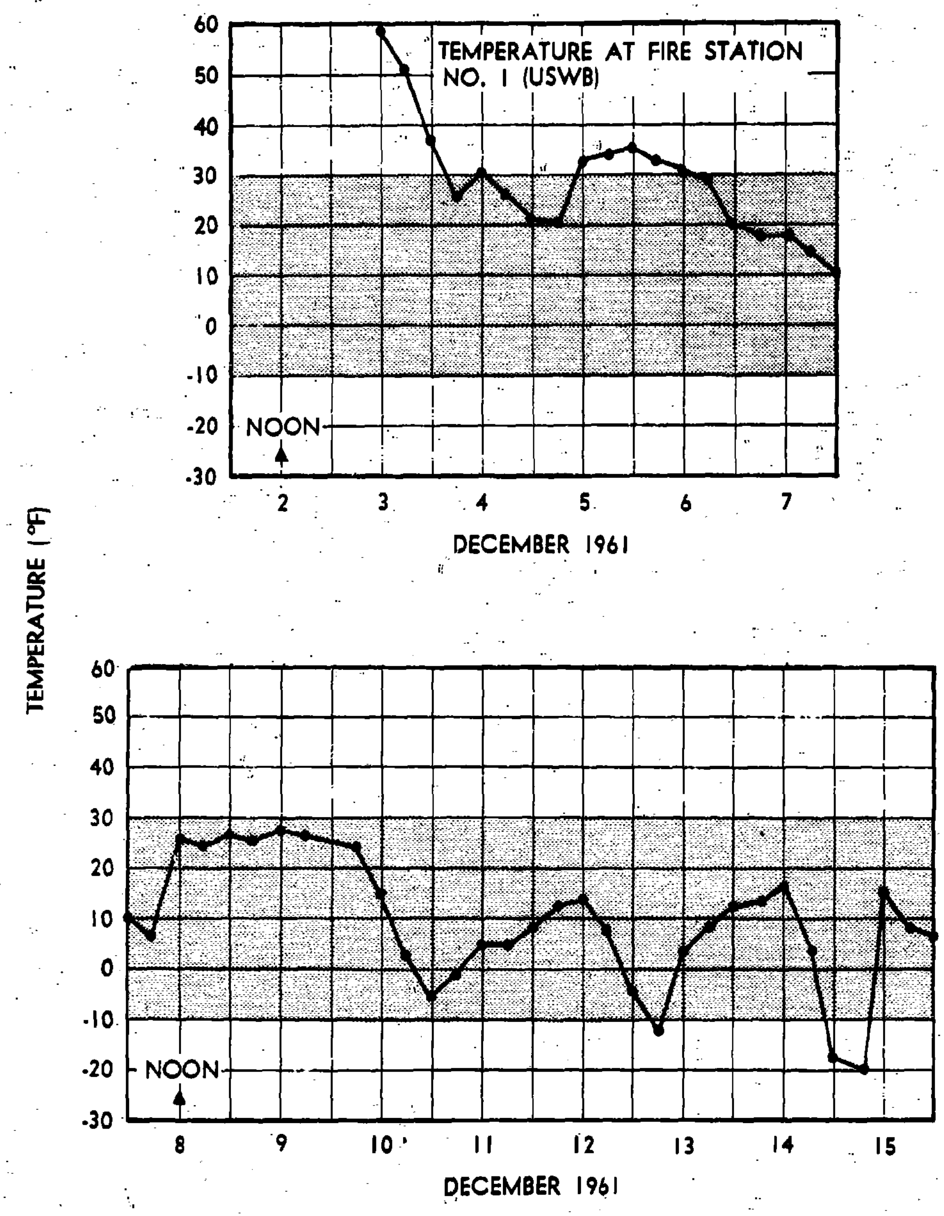


FIGURE D-2 CAMP McCOY AIR-TEMPERATURE PROFILES DURING TEST PERIOD

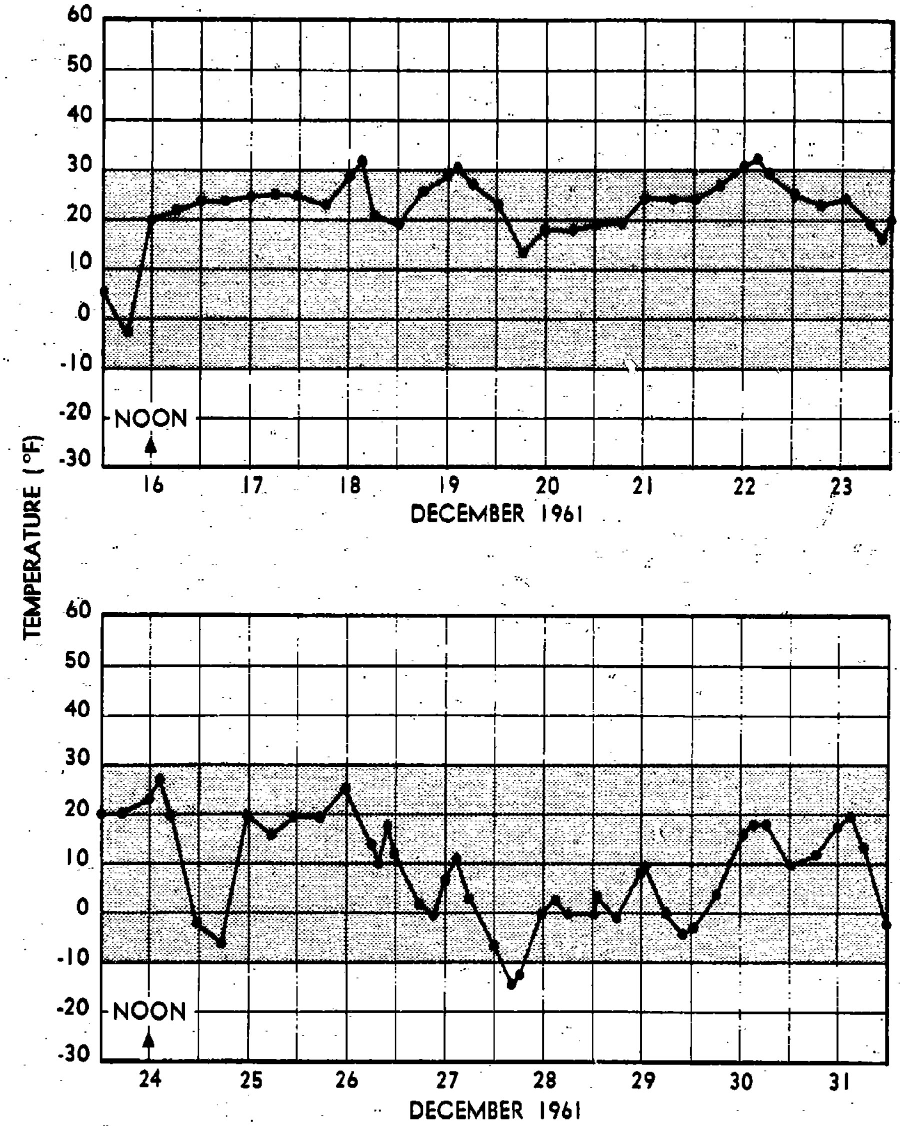


FIGURE D-2 (Cont'd)

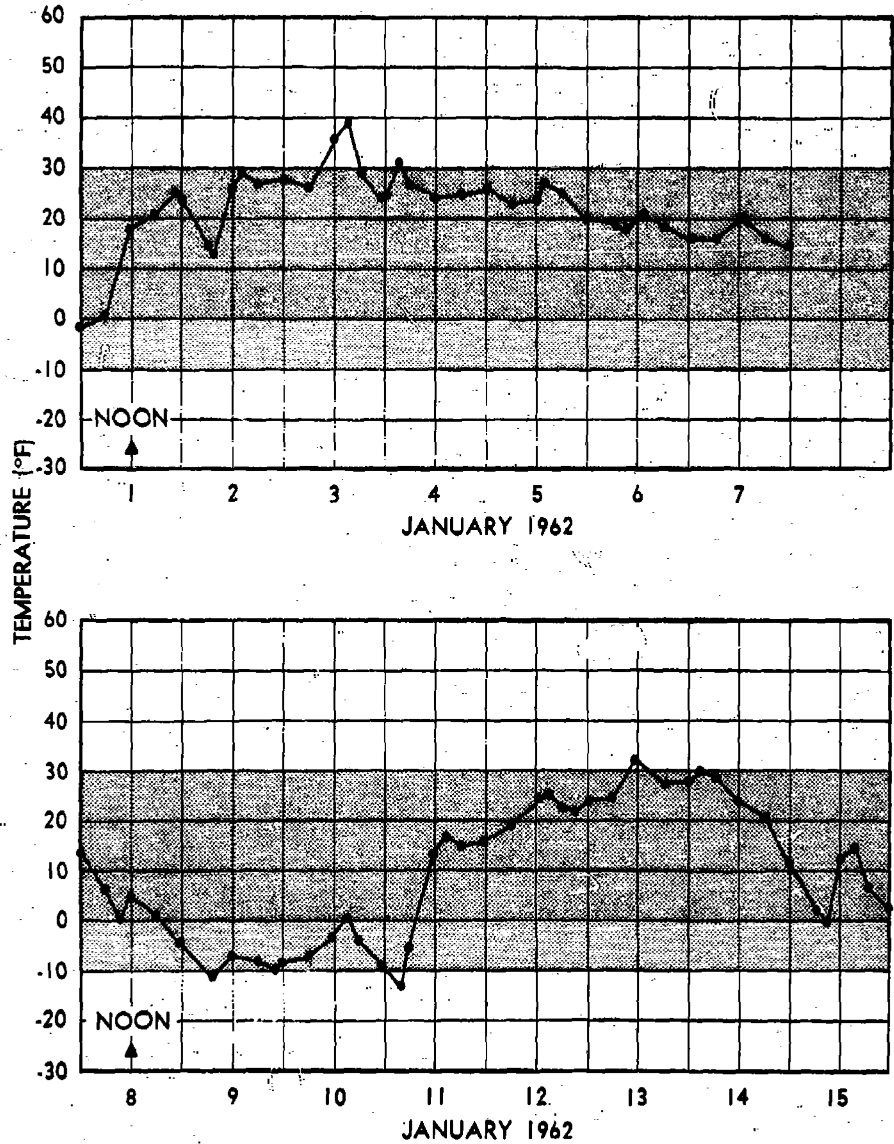


FIGURE D-2 (Cont'd)

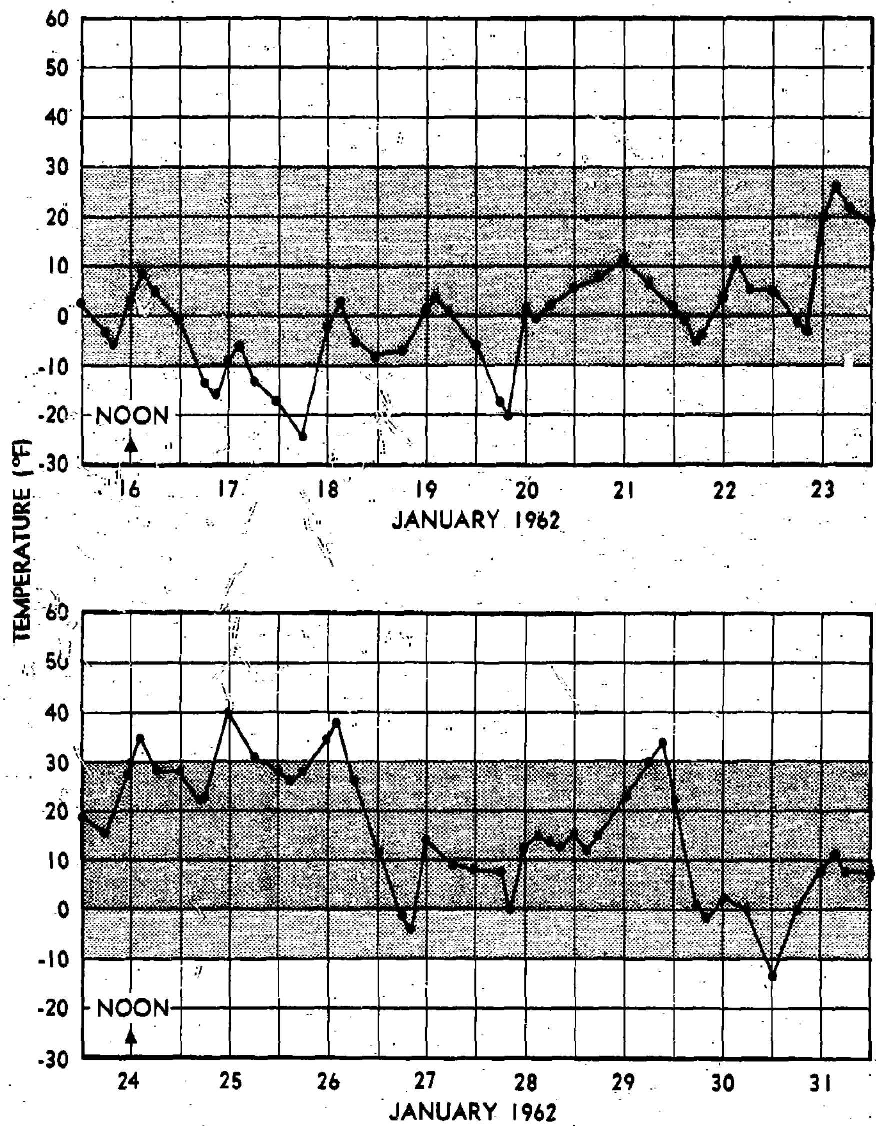


FIGURE D-2 (Cont'd)

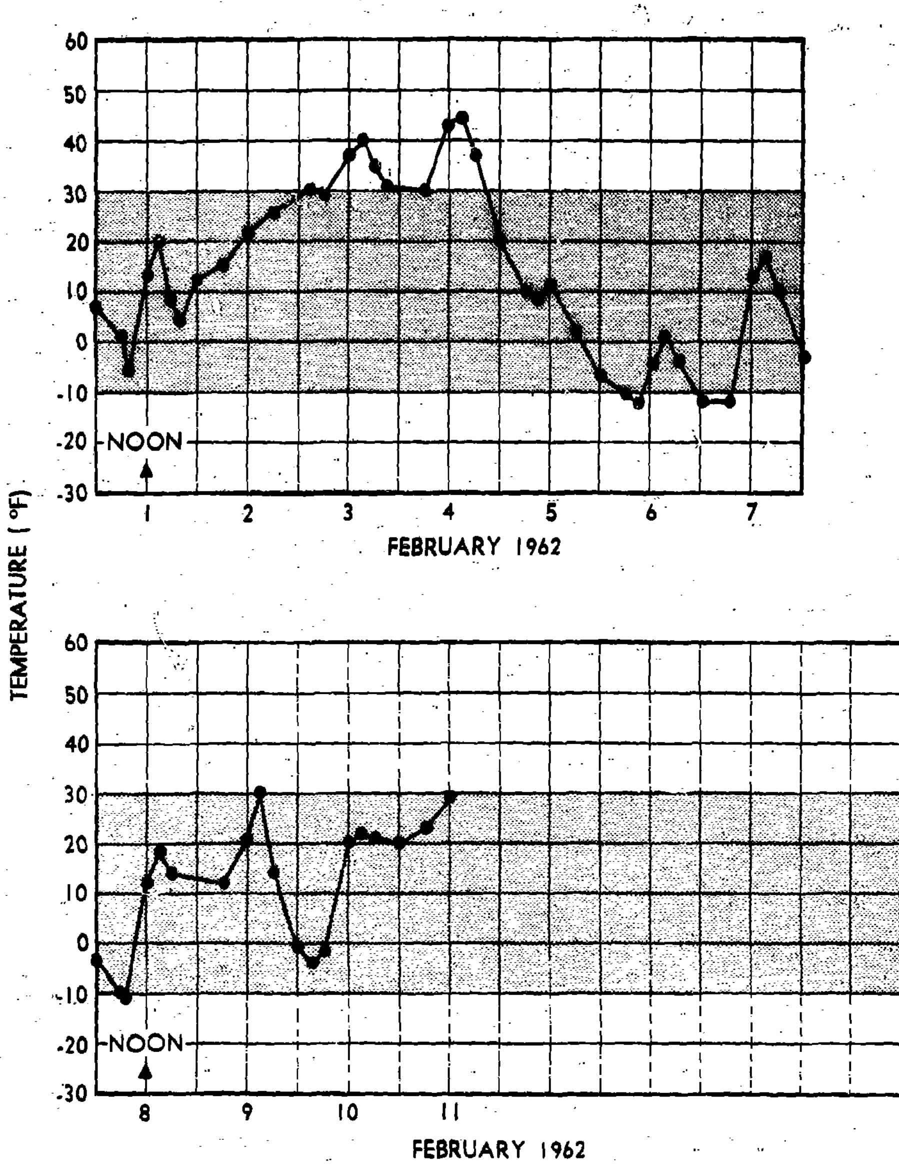


FIGURE D-2 (Cont'd)

NPC 16,568

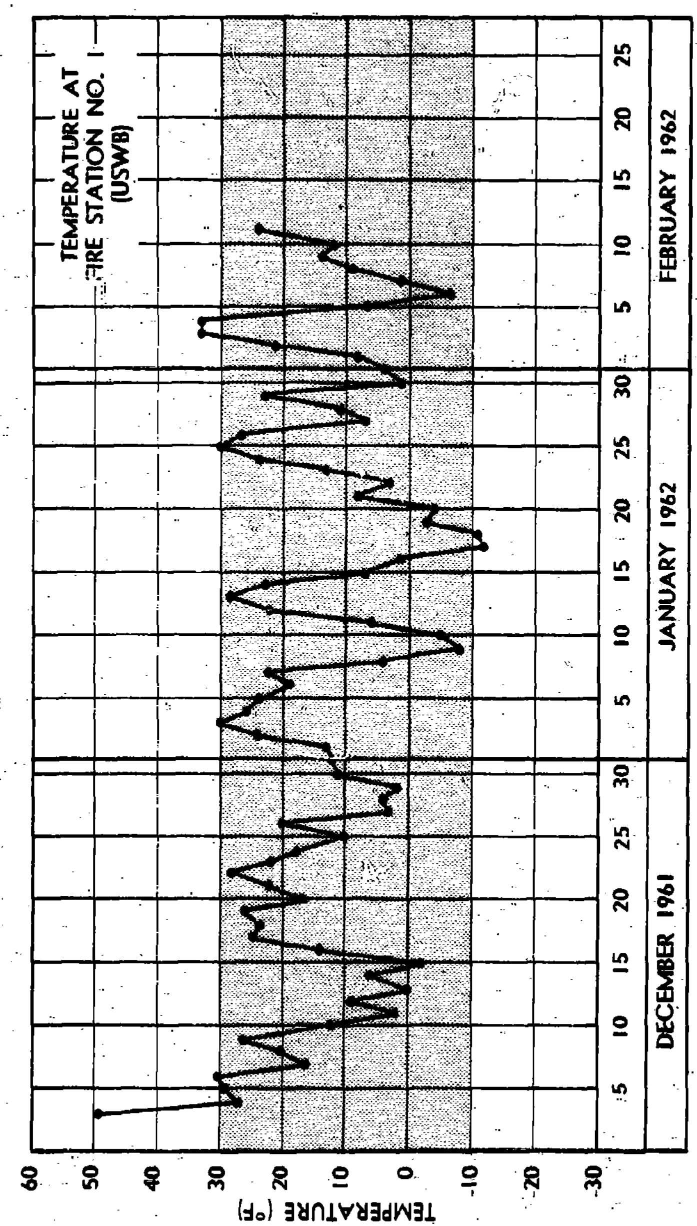


FIGURE D-3 DAILY MEAN AIR-TEMPERATURE PROFILE

TABLE D-1

AIR AND SURFACE TEMPERATURES NEAR BUILDING 447
(°F)

Time of Day	Location of Thermocouples				
	A	B	C	D	E
6 Feb 1962					
1400	5	2	4	-1	5
1600	4	3	7	0	4
1800	3	-3	-4	-7	-4
2000	1	-9	-14	-15	-12
2200	-1	-9	-16	-17	-16
7 Feb 1962					
0000	-2	-9	-17	-18	-13
0200	-4	-11	-17	-18	-17
0400	-4	-11	-17	-18	-15
0600	-3	-10	-17	-18	-16
0800	-1	-7	-13	-13	-10
1000	0	4	20	7	24
1200	9	13	16	10	18

A. Buried four inches deep in snow.

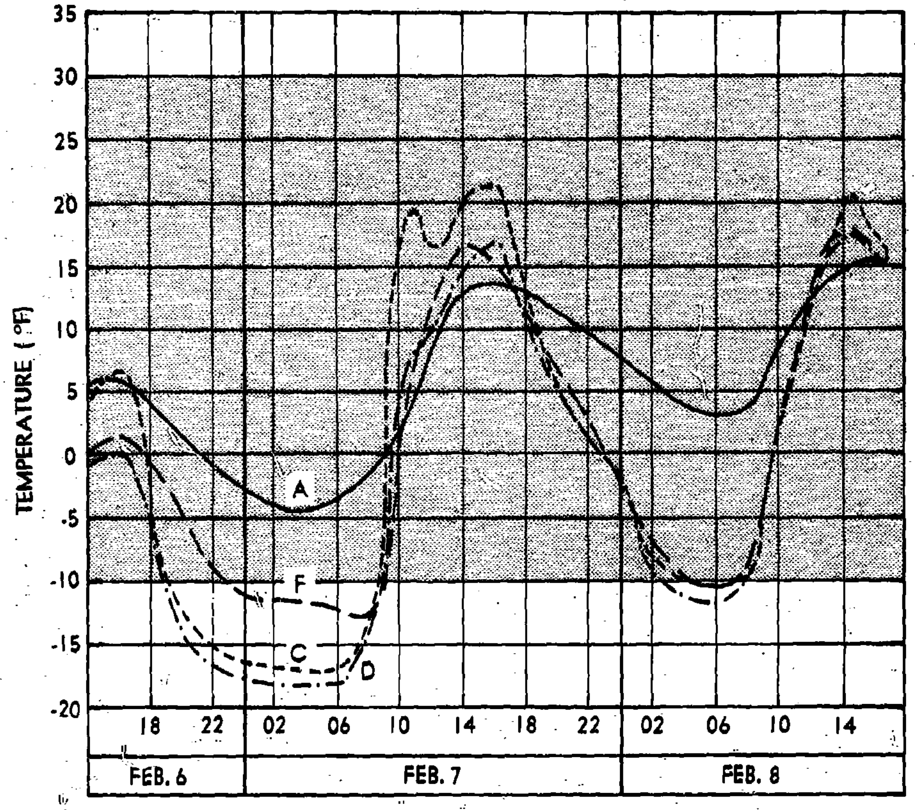
B. On surface of snow under block of wood.

C. On snow surface without shield.

D. Mounted in air four feet above surface with a white paper shield.

E. Mounted six inches from wall of heated building at a position four feet from ground and exposed to sunlight.

NPC 16,569



LOCATION OF THERMOCOUPLES

A. BURIED FOUR INCHES IN SNOW
C. ON SURFACE OF SNOW WITHOUT SHIELD
D. MOUNTED IN AIR FOUR FEET ABOVE SURFACE WITH A WHITE PAPER SHIELD
F. FIRE STATION NO. 1 (USWB)

FIGURE D-4 AIR AND SURFACE TEMPERATURE PROFILES

TABLE D-2

SNOW DENSITIES DURING TEST PERIOD

Date 1962	Air Temperature (°F)	Snow Depth (in.)	Snow Density (gm/mℓ)
Jan 5	27	6.2	0.239
10	1	6.0	0.255
11	16	6.0	0.265
15	9	6.0	0.270
20	2	5.5	0.281
25	34	4.5	0.320
26	35	4.0	0.330
31	8	4.2	0.402
Feb 1	13	4.7	0.380
2	23	4.9	0.346
3-4	20 to 44	Thawing	
6	1	3.2	0.376
15	19	5.5 (Packed)	0.310
		0.65 (Loose snow)	0.190

All measurements except those made on February 15 were made in the open field area near Building 447. There was no appreciable drift during period. Air temperatures were measured at the time samples were taken.

The February 15th measurements were made in a wooded area near Building 447 where the shielding study was conducted.

APPENDIX E

TEST-PLOT DECONTAMINATION DATA

The test-plot decontamination data are presented in tables E-1 through E-42. The tables are arranged in the same order as data presented in table II-3.

The test-plots, with the exception of the roof and the bare-concrete plots, measured 20 by 100 feet. Each scan (represented by a scan number in the tables) was made across the center of a 10-foot-wide strip, making a total of 10 scans per plot. The anthracene scintillation detector (ASD), used to measure the contaminant intensity, was sensitive to a 1-foot-wide strip as it was traversed. A complete description of the scanning equipment and instrumentation is given in Appendix C.

The bare-concrete plot measured 20 by 60 feet and required only 6 scans. The roof plots were scanned by hand, with a portable survey meter at a probe height of 3.0 feet.

The radiation level values and specific activity of simulant have been corrected for decay to the time of contamination. Averages are given with a 90% confidence interval.

TABLE E-1

TEST-PLOT DECONTAMINATION DATA

10 Jan 1962

EQUIPMENT Mechanical Sweeper SURFACE Bare Ground

Temperature (°F)

Air -6 Surface -4

Median Time of:

Contamination 1021

Decontamination 1050

Time to Decontaminate 2.60 min

Contamination Level 6.5 ±0.2 μc/gm

Deposition Level 44.0 ±24.2 gm/ft^2

Activity Level 0.286 mc/ft^2

Dose Rate to Operator 27 mr/hr

Operator Time 0.043 man-hours

SCANNER DATA			
Scan no.	Contamination radiation level*	Decontamination radiation level*	Activity removed (%)
1	29.7	1.10	96.3
2	25.9	2.36	90.6
3	25.9	1.04	96.0
4	28.7	0.74	97.4
5	23.1	1.02	95.6
6	26.8	1.98	92.6
7	29.2	3.55	87.8
8	21.8	5.16	76.3
9	27.0	9.08	66.4
10	14.6	5.73	60.8
AVERAGE	25.3 ±2.6		86.0 ±7.8

* Values are proportional to the radiation intensity.

TABLE E-2

TEST-PLOT DECONTAMINATION DATA

23 Jan 1962

EQUIPMENT Mechanical Sweeper SURFACE Bare Ground

Temperature (°F)
Air 22 Surface 20
Median Time of:
Contamination 1308
Decontamination 1327
Time to Decontaminate 1.50 min

Contamination Level 16.7 μc/gm
Deposition Level 40.8 gm/ft^2
Activity Level 0.681 mc/ft^2
Dose Rate to Operator 40 mr/hr
Operator Time 0.025 man-hours

SCANNER DATA			
Scan no.	Contamination radiation level*	Decontamination radiation level*	Activity removed (%)
1	54.1	1.83	96.6
2	63.2	3.65	94.2
3	60.2	3.91	93.5
4	61.1	5.72	90.6
5	63.9	7.09	88.9
6	97.9	7.96	91.9
7	59.2	6.75	88.6
8	62.3	8.52	86.3
9	64.3	9.22	85.7
10	61.7	7.74	87.5
AVERAGE	64.8 ±7.0		90.4 ±2.1

* Values are proportional to the radiation intensity.

TABLE E-3

TEST-PLOT DECONTAMINATION DATA

5 Jan 1962

EQUIPMENT Mechanical Sweeper SURFACE Bare Ground

Temperature (°F)
Air 26 Surface 27
Median Time of:
Contamination 1518
Decontamination 1536
Time to Decontaminate 5.33 min

Contamination Level 10.3 ±3.6 μc/gm
Deposition Level 47.2 ±12.2 gm/ft^2
Activity Level 0.487 mc/ft^2
Dose Rate to Operator 50 mr/hr
Operator Time 0.089 man-hours

SCANNER DATA			
Scan no.	Contamination radiation level*	Decontamination radiation level*	Activity removed (%)
1	19.1	2.47	87.1
2	26.0	4.61	82.3
3	30.6	4.72	84.6
4	31.6	4.99	84.2
5	29.4	4.66	84.2
6	33.2	4.84	85.4
7	30.0	4.10	86.3
8	28.4	2.76	90.3
9	33.4	3.02	91.0
10	20.2	2.01	90.1
AVERAGE	27.2 ±2.7		86.6 ±1.7

* Values are proportional to the radiation intensity.

TABLE E-4

TEST-PLOT DECONTAMINATION DATA

17 Jan 1962

EQUIPMENT Vacuum Sweeper SURFACE Bare Ground

Temperature (°F)
Air -15 Surface -14
Median Time of:
Contamination 0736
Decontamination 0815
Time to Decontaminate 1.50 min

Contamination Level 16.4 ±2.1 μc/gm
Deposition Level 54.1 ±24.3 gm/ft²
Activity Level 0.885 mc/ft²
Dose Rate to Operator 40 mr/hr
Operator Time 0.025 man-hours

SCANNER DATA

Scan no.	Contamination radiation level*	Decontamination radiation level*	Activity removed (%)
1	35.1	4.09	88.3
2	53.1	7.52	85.8
3	64.5	8.20	87.3
4	68.3	6.77	90.1
5	67.2	9.50	85.9
6	73.2	8.75	88.0
7	70.9	7.35	89.6
8	68.0	6.95	89.8
9	65.5	8.47	87.1
10	67.7	8.06	88.1
AVERAGE	63.4 ±6.6		88.0 ±0.9

* Values are proportional to the radiation intensity.

TABLE E-5

TEST-PLOT DECONTAMINATION DATA

30 Dec 1961

EQUIPMENT Vacuum Sweeper SURFACE Bare Ground

Temperature (°F)
Air 18 Surface 18
Median Time of:
Contamination 1220
Decontamination 1443
Time to Decontaminate 4.00 min

Contamination Level 7.5 ±0.8 μc/gm
Deposition Level 34.6 ±29.1 gm/ft^2
Activity Level 0.258 mc/ft^2
Dose Rate to Operator 19 mr/hr
Operator Time 0.067 man-hours

SCANNER DATA

Scan no.	Contamination radiation level*	Decontamination radiation level*	Activity removed (%)
1	16.2	9.58	40.9
2	17.1	9.10	46.8
3	21.8	11.90	45.4
4	19.6	12.32	37.2
5	26.1	15.38	41.1
6	23.3	13.66	41.4
7	18.8	16.06	14.6
8	24.5	13.81	43.6
9	24.5	12.82	47.7
10	17.7	11.80	33.3
11	10.6	8.93	15.8
AVERAGE	20.0 ±2.5		37.1 ±6.4

* Values are proportional to the radiation intensity.

REMARKS: Vacuum sweeper broke down at 1230, but was repaired before decontamination.

TABLE E-6

TEST-PLOT DECONTAMINATION DATA

5 Jan 1962

EQUIPMENT Vacuum Sweeper SURFACE Bare Ground

Temperature (°F)
Air 26 Surface 27
Median Time of:
Contamination 1410
Decontamination 1425
Time to Decontaminate 4.00min

Contamination Level 8.5 ±2.3 μc/gm
Deposition Level 53.8 ±22.2 gm/ft^2
Activity Level 0.458 mc/ft^2
Dose Rate to Operator 15 mr/hr
Operator Time 0.067 man-hours

SCANNER DATA

Scan no.	Contamination radiation level*	Decontamination radiation level*	Activity removed (%)
1	18.9	5.31	71.9
2	29.2	7.52	74.2
3	28.2	8.80	68.8
4	32.0	9.22	71.2
5	33.5	12.71	62.0
6	32.7	10.57	67.7
7	32.5	6.40	80.3
8	31.3	8.70	72.2
9	28.4	10.48	63.2
10	30.0	9.56	68.1
AVERAGE	29.7 ±2.4		70.0 ±3.1

* Values are proportional to the radiation intensity.

TABLE E-7

TEST-PLOT DECONTAMINATION DATA

10 Jan 1962

EQUIPMENT Motor Grader SURFACE Bare Ground

Temperature (°F)

Air -3 Surface -1

Median Time of:

Contamination 1154

Decontamination 1241

Time to Decontaminate 10.00 min

Contamination Level 6.0 ±0.3 μc/gm

Deposition Level 47.3 ±18.4 gm/ft^2

Activity Level 0.285 mc/ft^2

Dose Rate to Operator 15 mr/hr

Operator Time 0.167 man-hours

SCANNER DATA

Scan no.	Contamination radiation level*	Decontamination radiation level*	Activity removed (%)
1	25.4	22.8	10.2
2	27.9	24.4	12.5
3	35.6	27.4	23.0
4	32.6	19.1	41.4
5	24.0	36.5	-52.1
6	29.6	23.3	21.3
7	26.7	24.4	8.6
8	25.9	28.1	-8.5
9	20.9	14.5	30.6
10	29.5	23.2	21.4
AVERAGE	27.8 ±2.4		10.8 ±15.0

* Values are proportional to the radiation intensity.

REMARKS: Ground was frozen too hard for blade to penetrate.

TABLE E-8

TEST-PLOT DECONTAMINATION DATA

20 Jan 1962

EQUIPMENT Fire Hosing SURFACE Bare Ground

Temperature (°F)
Air 0 Surface -1
Median Time of:
Contamination 1130
Decontamination 1212
Time to Decontaminate 7.25 min

Contamination Level 7.7 μc/gm
Deposition Level 46.3 gm/ft^2
Activity Level 0.357 mc/ft^2
Dose Rate to Operator 12 mr/hr
Operator Time 0.483 man-hours

SCANNER DATA			
Scan no.	Contamination radiation level*	Decontamination radiation level*	Activity removed (%)
1	31.7	7.62	75.9
2	35.9	6.75	81.2
3	31.6	11.72	62.9
4	35.0	9.42	73.1
5	40.4	25.34	37.3
6	36.1	17.92	50.4
7	33.8	20.19	40.3
8	42.2	27.02	36.0
9	30.2	21.55	28.6
10	32.6	27.30	16.3
AVERAGE	35.0 ±2.2		50.2 ±12.8

* Values are proportional to the radiation intensity.

REMARKS: 1. Fire hose had a 2.5-inch nozzle with a 1-inch bore.

2. Four men worked simultaneously for 7.25 minutes.

TABLE E-9

TEST-PLOT DECONTAMINATION DATA

19 Jan 1962

EQUIPMENT Fire Hosing SURFACE Bare Ground

Temperature (°F)
Air 4 Surface 10
Median Time of:
Contamination 1446
Decontamination 1558
Time to Decontaminate 9.00 min

Contamination Level 10.1 µc/gm
Deposition Level 53.6 gm/ft^2
Activity Level 0.541 mc/ft^2
Dose Rate to Operator 15 mr/hr
Operator Time 0.600 man-hours

SCANNER DATA

Scan no.	Contamination radiation level*	Decontamination radiation level*	Activity removed (%)
1	30.9	22.8	26.2
2	47.2	15.3	67.6
3	51.8	15.8	69.5
4	47.1	14.2	70.0
5	35.7	12.9	63.9
6	47.5	6.4	86.5
7	48.5	33.1	31.8
8	36.2	20.0	44.8
9	44.0	19.1	56.6
10	22.3	14.2	36.3
AVERAGE	41.1 ±5.5		55.3 ±11.4

* Values are proportional to the radiation intensity.

REMARKS: 1. Fire hose had a 2.5-inch nozzle with a 1-inch bore.

2. Four men worked simultaneously for 9 minutes.

TABLE E-10

TEST-PLOT DECONTAMINATION DATA

6 Jan 1962

EQUIPMENT Fire Hosing SURFACE Bare Ground

Temperature (°F)
Air 20 Surface 21
Median Time of:
Contamination 1143
Decontamination 1220
Time to Decontaminate 2.50 min

Contamination Level 14.1 ±4.4 μc/gm
Deposition Level 43.7 ±22.2 gm/ft^2
Activity Level 0.618 mc/ft^2
Dose Rate to Operator 20 mr/hr
Operator Time 0.167 man-hours

SCANNER DATA			
Scan no.	Contamination radiation level*	Decontamination radiation level*	Activity removed (%)
1	20.6	14.7	28.6
2	30.6	23.6	22.9
3	40.1	34.0	15.2
4	40.8	31.1	23.8
5	44.7	38.5	13.9
6	46.4	41.8	9.9
7	44.4	44.2	0.5
8	44.2	38.7	12.4
9	45.2	35.2	22.1
10	38.6	37.8	2.1
AVERAGE	39.6 ±4.8		15.1 ±7.0

* Values are proportional to the radiation intensity.

REMARKS: 1. Fire hose had a 1.5-inch fog nozzle with an adjustable bore.
2. Four men worked simultaneously for 2.5 minutes.

TABLE E-11

TEST-PLOT DECONTAMINATION DATA

24 Jan 1962

EQUIPMENT Rotary Broom Sweeper SURFACE Bare Ground

Temperature (°F)

Air 34 Surface 33

Median Time of:

Contamination 1444

Decontamination 1510

Time to Decontaminate 1.33 min

Contamination Level 10.5 ±0.3 μc/gm

Deposition Level 51.4 ±39.6 gm/ft^2

Activity Level 0.539 mc/ft^2

Dose Rate to Operator 40 mr/hr

Operator Time 0.022 man-hours

SCANNER DATA			
Scan no.	Contamination radiation level*	Decontamination radiation level*	Activity removed (%)
1	41.9	27.1	35.3
2	54.4	15.2	72.1
3	42.6	5.6	86.9
4	35.7	21.6	39.5
5	43.0	18.6	56.7
6	35.7	8.5	76.2
7	31.3	11.0	64.9
8	36.9	7.9	78.6
9	32.4	6.4	80.2
AVERAGE	39.3 ±4.5		65.6 ±11.3

* Values are proportional to the radiation intensity.

TABLE E-12

TEST-PLOT DECONTAMINATION DATA

9 Jan 1962

EQUIPMENT Mechanical Sweeper SURFACE Bare Asphalt

Temperature (°F)

Air -11 Surface -8

Median Time of:

Contamination 0823

Decontamination 0855

Time to Decontaminate 1.73 min

Contamination Level 5.5 ±0.2 μc/gm

Deposition Level 41.4 ±19.4 gm/ft^2

Activity Level 0.226 mc/ft^2

Dose Rate to Operator 15 mr/hr

Operator Time 0.029 man-hours

SCANNER DATA			
Scan no.	Contamination radiation level*	Decontamination radiation level*	Activity removed (%)
1	17.7	1.24	93.0
2	17.6	1.35	92.3
3	20.9	1.35	93.5
4	22.2	1.24	94.4
5	21.1	1.17	94.5
6	22.2	1.09	95.1
7	25.9	1.04	96.0
8	21.2	0.86	95.9
AVERAGE	21.1 ±1.5		94.3 ±0.9

* Values are proportional to the radiation intensity.

TABLE E-13

TEST-PLOT DECONTAMINATION DATA

30 Dec 1961

EQUIPMENT Mechanical Sweeper SURFACE Bare Asphalt

Temperature (°F)

Air 7 Surface 8

Median Time of:

Contamination 0845

Decontamination 0931

Time to Decontaminate 2.50 min

Contamination Level 4.6 ±3.1 μc/gm

Deposition Level 39.2 ±6.4 gm/ft^2

Activity Level 0.180 mc/ft^2

Dose Rate to Operator 11 mr/hr

Operator Time 0.042 man-hours

SCANNER DATA

Scan no.	Contamination radiation level*	Decontamination radiation level*	Activity removed (%)
1	10.2	3.92	61.6
2	11.1	3.81	65.7
3	12.2	3.46	71.6
4	12.8	3.43	73.2
5	15.2	3.65	76.0
6	16.2	3.84	76.3
7	13.0	3.73	71.3
8	14.8	4.20	71.3
9	24.0	4.58	80.9
10	15.2	3.22	78.8
11	18.2	3.59	80.3
AVERAGE	14.8 ±2.2		73.4 ±1.0

* Values are proportional to the radiation intensity.

REMARKS: Main brush mounting loosened as sweeper made its third decontamination pass.

TABLE E-14

TEST-PLOT DECONTAMINATION DATA

17 Jan 1962

EQUIPMENT Fire Hosing SURFACE Bare Asphalt

Temperature (°F)

Air 0 Surface -4

Median Time of:

Contamination 1517

Decontamination 1619

Time to Decontaminate 10.50 min

Contamination Level 16.6 ±0.5 μc/gm

Deposition Level 49.8 ±17.8 gm/ft^2

Activity Level 0.825 mc/ft^2

Dose Rate to Operator 30 mr/hr

Operator Time 0.700 man-hours

SCANNER DATA			
Scan no.	Contamination radiation level*	Decontamination radiation level*	Activity removed (%)
1	71.6	3.94	94.5
2	65.5	3.82	94.2
3	73.5	4.23	94.2
4	98.7	7.29	92.6
5	76.3	4.62	93.9
6	83.0	7.70	90.7
7	72.2	1.66	97.7
8	67.6	6.92	89.8
9	85.3	8.91	89.6
AVERAGE	74.7 ±6.5		93.0 ±1.6

* Values are proportional to the radiation intensity.

REMARKS: 1. Fire hose had a 2.5-inch nozzle with a 1-inch bore.

2. Four men worked simultaneously for 10.5 minutes.

TABLE E-15

TEST-PLOT DECONTAMINATION DATA

9 Jan 1962

EQUIPMENT Mechanical Sweeper SURFACE Bare Concrete

Temperature (°F)
Air -7 Surface -3
Median Time of:
Contamination 1218
Decontamination 1240
Time to Decontaminate 0.73 min

Contamination Level 4.8 ±0.2 μc/gm
Deposition Level 45.2 ±48.7 gm/ft²
Activity Level 0.215 mc/ft²
Dose Rate to Operator 12 mr/hr
Operator Time 0.012 man-hours

SCANNER DATA			
Scan no.	Contamination radiation level*	Decontamination radiation level*	Activity removed (%)
1	17.3	0.86	95.0
2	21.4	1.13	94.7
3	18.0	0.96	94.7
4	14.8	1.39	90.6
5	17.6	0.90	94.9
6	10.6	0.95	91.0
AVERAGE	16.6 ±3.0		93.5 ±1.6

* Values are proportional to the radiation intensity.

REMARKS: Concrete plot measured 20 x 60 feet.

TABLE E-16a

TEST-PLOT DECONTAMINATION DATA

30 Dec 1961

EQUIPMENT Vacuum Sweeper

SURFACE Bare Concrete

Temperature (°F)
Air 18 Surface 16

Median Time of:
Contamination 1130
Decontamination 1150

Time to Decontaminate 4.00 min

(First Decontamination)

Contamination Level 7.8 ±3.1 μc/gm

Deposition Level 32.3 ±26.5 gm/ft^2

Activity Level 0.250 mc/ft^2

Dose Rate to Operator 23 mr/hr

Operator Time 0.067 man-hours

SCANNER DATA			
Scan no.	Contamination radiation level*	Decontamination radiation level*	Activity removed (%)
1	18.7	4.78	74.4
2	23.2	5.00	78.4
3	19.1	5.89	69.2
4	28.1	1.13	96.0
5	34.8	2.93	91.6
AVERAGE	24.8 ±6.4		81.9 ±10.9

* Values are proportional to the radiation intensity.

REMARKS: Concrete plot measured 20 x 60 feet.

TABLE E-16b

TEST-PLOT DECONTAMINATION DATA

30 Dec 1961

EQUIPMENT	Vacuum Sweeper	SURFACE	Bare Concrete
Temperature (°F)		(Second Decontamination)	
Air 18 Surface	16	Contamination Level	μc/gm
Median Time of:		Deposition Level	gm/ft^2
Contamination	1130	Activity Level	mc/ft^2
Decontamination	1516	Dose Rate to Operator	mr/hr
Time to Decontaminate	9.00 min	Operator Time	0.150 man-hours

SCANNER DATA

Scan no.	Contamination radiation level*	Decontamination radiation level*	Activity removed (%)
1	18.7	3.43	81.7
2	23.2	2.03	91.3
3	19.1	3.25	83.0
4	28.1	3.24	88.5
5	34.8	4.01	88.5
AVERAGE	24.8 ±6.4		86.6 ±3.9

* Values are proportional to the radiation intensity.

REMARKS: 1. Since the simulant had been partially removed by the first decontamination, the activity level was not known.

2. The operator time and efficiency index are based on total time for two decontaminations.

TABLE E-17

TEST-PLOT DECONTAMINATION DATA

19 Jan 1962

EQUIPMENT	Fire Hosing	SURFACE	Bare Concrete
Temperature (°F) Air	-1 Surface 0	Contamination Level	6.9 μc/gm
Median Time of:		Deposition Level	48.3 gm/ft^2
Contamination	1036	Activity Level	0.333 mc/ft^2
Decontamination	1123	Dose Rate to Operator	6 mr/hr
Time to Decontaminate	10.00 min	Operator Time	0.667 man-hours

SCANNER DATA

Scan no.	Contamination radiation level*	Decontamination radiation level*	Activity removed (%)
1	31.9	4.40	86.2
2	27.9	5.94	78.7
3	27.8	6.44	76.8
4	40.3	17.88	55.6
5	28.8	36.57	-27.0
6	11.5	12.96	-12.7
AVERAGE	28.0 ±6.6		42.9 ±41.0

* Values are proportional to the radiation intensity.

REMARKS: 1. Concrete plot measured 20 x 60 feet.

2. Fire hose had a 2.5-inch nozzle with a 1-inch bore.

3. Four men worked simultaneously for 10 minutes.

TABLE E-18

TEST-PLOT DECONTAMINATION DATA

20 Jan 1962

EQUIPMENT Fire Hosing SURFACE Bare Concrete

Temperature (°F)

Air 2 Surface 3

Median Time of:

Contamination 1440

Decontamination 1501

Time to Decontaminate 3.50 min

Contamination Level 7.3 μc/gm

Deposition Level 54.7 gm/ft^2

Activity Level 0.399 mc/ft^2

Dose Rate to Operator 6 mr/hr

Operator Time 0.233 man-hours

SCANNER DATA			
Scan no.	Contamination radiation level*	Decontamination radiation level*	Activity removed (%)
1	45.4	5.27	88.4
2	29.2	2.95	89.9
3	39.2	2.06	94.7
4	32.1	1.42	95.6
5	38.2	1.36	96.4
6	32.9	1.77	94.6
AVERAGE	36.2 ±4.8		93.3 ±2.7

* Values are proportional to the radiation intensity.

REMARKS: 1. Concrete plot measured 20 x 60 feet.

2. Fire hose had a 2.5-inch nozzle with a 1-inch bore.

3. Four men worked simultaneously for 3.5 minutes.

TABLE E-19

TEST PLOT DECONTAMINATION DATA

9 Jan 1962

EQUIPMENT Mechanical Sweeper SURFACE Packed Snow

Temperature (°F)
Air -6 Surface -4
Median Time of:
Contamination 1357
Decontamination 1421
Time to Decontaminate 1.25 min

Contamination Level 4.7 ±0.3 μc/gm
Deposition Level 44.6 ±18.4 gm/ft^2
Activity Level 0.208 mc/ft^2
Dose Rate to Operator 35 mr/hr
Operator Time 0.021 man-hours

SCANNER DATA

Scan no.	Contamination radiation level*	Decontamination radiation level*	Activity removed (%)
1	25.5	1.32	94.8
2	21.9	0.35	98.4
3	20.2	1.83	90.9
4	20.8	1.96	90.6
5	21.7	1.29	94.1
6	20.9	0.90	95.7
7	21.4	0.47	97.8
8	17.4	0.92	94.7
9	17.3	1.70	90.2
10	3.6	0.48	86.7
AVERAGE	19.1 ±3.5		93.4 ±2.1

* Values are proportional to the radiation intensity.

TABLE E-20

TEST-PLOT DECONTAMINATION DATA

23 Jan 1962

EQUIPMENT Mechanical Sweeper SURFACE Packed Snow

Temperature (°F)
Air 24 Surface 20
Median Time of:
Contamination 1446
Decontamination 1516
Time to Decontaminate 2.00 min

Contamination Level 14.5 ±1.2 μc/gm
Deposition Level 33.5 ±26.2 gm/ft^2
Activity Level 0.486 mc/ft^2
Dose Rate to Operator 25 mr/hr
Operator Time 0.033 man-hours

SCANNER DATA

Scan no	Contamination radiation level*	Decontamination radiation level*	Activity removed (%)
1	35.6	2.38	93.3
2	48.7	3.91	92.0
3	67.2	3.16	95.3
4	73.0	3.94	94.6
5	40.1	2.45	93.9
6	64.7	2.25	96.5
7	50.1	3.65	92.7
8	61.2	3.36	94.5
9	62.5	2.81	95.5
10	51.0	3.04	94.0
AVERAGE	55.4 ±7.1		94.2 ±0.8

* Values are proportional to the radiation intensity.

TABLE E-21a

TEST-PLOT DECONTAMINATION DATA

5 Jan 1962

EQUIPMENT Mechanical Sweeper SURFACE Packed Snow

Temperature (°F)
Air 24 Surface 26
Median Time of:
Contamination 1100
Decontamination 1117
Time to Decontaminate 2.00 min

(First Decontamination)
Contamination Level 11.8 ±3.8 μc/gm
Deposition Level 47.3 ±24.8 gm/ft^2
Activity Level 0.555 mc/ft^2
Dose Rate to Operator 22 mr/hr
Operator Time 0.033 man-hours

SCANNER DATA			
Scan no.	Contamination radiation level*	Decontamination radiation level*	Activity removed (%)
1	27.6	13.1	52.5
2	43.0	15.7	63.5
3	31.5	14.1	55.2
4	32.7	13.6	58.4
5	28.8	13.1	54.4
6	30.9	13.6	56.0
7	20.3	15.7	22.7
8	26.9	11.3	58.0
9	20.9	10.9	47.8
10	11.7	8.8	24.8
AVERAGE	27.4 ±4.9		49.3 ±8.2

* Values are proportional to the radiation intensity.

REMARKS: Hopper was cleaned out and brushes were adjusted after this test.

TABLE E-21b

TEST-PLOT DECONTAMINATION DATA

5 Jan 1962

EQUIPMENT Mechanical Sweeper SURFACE Packed Snow

Temperature (°F)
Air 24 Surface 26
Median Time of:
Contamination 1100
Decontamination 1136
Time to Decontaminate 4.00 min

(Second Decontamination)
Contamination Level ______ μc/gm
Deposition Level ______ gm/ft^2
Activity Level ______ mc/ft^2
Dose Rate to Operator ______ mr/hr
Operator Time 0.067 man-hours

SCANNER DATA			
Scan no.	Contamination radiation level*	Decontamination radiation level*	Activity removed (%)
1	27.6	3.44	87.5
3	31.5	4.59	85.4
5	28.8	2.66	90.7
7	20.3	3.91	80.7
9	20.9	3.90	81.3
AVERAGE	25.8 ±10.7		85.1 ±4.0

* Values are proportional to the radiation intensity.

REMARKS: 1. Since the simulant had been partially removed by the first decontamination, the activity level was not known.

2. The operator time and efficiency index are based on total time for two decontaminations.

TABLE E-22

TEST-PLOT DECONTAMINATION DATA

9 Jan 1962

EQUIPMENT Vacuum Sweeper

SURFACE Packed Snow

Temperature (°F)

Air -7 Surface -8

Median Time of:

Contamination 1550

Decontamination 1606

Time to Decontaminate 3.00 min

Contamination Level 5.0 ±0.2 μc/gm

Deposition Level 53.7 ±6.3 gm/ft²

Activity Level 0.266 mc/ft²

Dose Rate to Operator 20 mr/hr

Operator Time 0.050 man-hours

SCANNER DATA

Scan no.	Contamination radiation level*	Decontamination radiation level*	Activity removed (%)
1	17.8	8.04	54.8
2	18.1	9.61	46.9
3	18.5	8.03	56.6
4	19.6	8.58	56.2
5	20.6	9.87	52.1
6	19.3	8.00	58.6
7	19.9	9.34	53.1
8	19.2	8.71	54.6
9	17.8	7.70	56.7
10	12.2	6.28	48.5
AVERAGE	18.3 ±1.3		53.8 ±2.2

* Values are proportional to the radiation intensity.

TABLE E-23

TEST-PLOT DECONTAMINATION DATA

29 Dec 1961

EQUIPMENT Vacuum Sweeper SURFACE Packed Snow

Temperature (°F)
Air 6 Surface 11
Median Time of:
Contamination 1549
Decontamination 1625
Time to Decontaminate 3.50 min

Contamination Level 11.1 ±6.3 μc/gm
Deposition Level 46.1 ±8.6 gm/ft²
Activity Level 0.512 mc/ft²
Dose Rate to Operator 19 mr/hr
Operator Time 0.058 man-hours

SCANNER DATA			
Scan no.	Contamination radiation level*	Decontamination radiation level*	Activity removed (%)
1	15.8	3.76	76.2
2	21.9	2.81	87.2
3	20.6	3.04	85.2
4	25.4	3.39	86.7
5	27.9	3.30	88.2
6	21.4	4.05	81.1
7	21.4	3.36	84.3
8	29.5	3.02	89.8
9	15.3	2.97	80.6
10	9.3	2.28	75.5
11	15.8	1.77	88.8
AVERAGE	20.4 ±3.3		84.0 ±2.7

* Values are proportional to the radiation intensity.

TABLE E-24

TEST-PLOT DECONTAMINATION DATA

5 Jan 1962

EQUIPMENT Vacuum Sweeper SURFACE Packed Snow

Temperature (°F)
Air 26 Surface 28
Median Time of:
Contamination 1317
Decontamination 1336
Time to Decontaminate 4.5 min

Contamination Level 10.3 ±1.8 μc/gm
Deposition Level 48.4 ±35.5 gm/ft^2
Activity Level 0.496 mc/ft^2
Dose Rate to Operator 15 mr/hr
Operator Time 0.075 man-hours

SCANNER DATA			
Scan no.	Contamination radiation level*	Decontamination radiation level*	Activity removed (%)
1	33.3	1.97	94.1
2	30.9	3.68	88.1
3	37.6	6.68	82.2
4	35.0	4.74	86.5
5	29.4	5.29	82.0
6	38.3	3.90	89.8
7	35.0	5.59	84.0
8	31.4	4.66	85.2
9	33.8	3.17	90.6
10	25.7	4.22	83.6
AVERAGE	33.1 ±2.2		86.6 ±2.3

* Values are proportional to the radiation intensity.

TABLE E-25

TEST-PLOT DECONTAMINATION DATA

9 Jan 1962

EQUIPMENT Motor Grader SURFACE Packed Snow

Temperature (°F)

Air -8 Surface -10

Median Time of:

Contamination 1645

Decontamination 1724

Time to Decontaminate 1.60 min

Contamination Level 5.2 ±0.3 μc/gm

Deposition Level 48.5 ±16.6 gm/ft^2

Activity Level 0.252 mc/ft^2

Dose Rate to Operator 20 mr/hr

Operator Time 0.027 man-hours

SCANNER DATA			
Scan no.	Contamination radiation level*	Decontamination radiation level*	Activity removed (%)
1	23.3	9.73	58.2
2	22.0	5.74	74.0
3	23.3	4.36	81.4
4	29.7	7.55	74.6
5	21.0	1.86	91.2
6	20.3	1.62	92.0
7	22.5	0.86	96.2
8	18.0	0.60	96.7
9	20.5	0.23	98.9
10	19.9	0.33	98.3
AVERAGE	22.1 ±1.8		86.2 ±7.9

* Values are proportional to the radiation intensity.

TABLE E-26a

TEST-PLOT DECONTAMINATION DATA

29 Dec 1961

EQUIPMENT Motor Grader

SURFACE Packed Snow

Temperature (°F)
Air 9 Surface 14
Median Time of:
Contamination 1342
Decontamination 1443
Time to Decontaminate 2.15 min

(First Decontamination)
Contamination Level 11.4 ±1.0 μc/gm
Deposition Level 39.0 ±0.4 gm/ft^2
Activity Level 0.443 mc/ft^2
Dose Rate to Operator 20 mr/hr
Operator Time 0.036 man-hours

SCANNER DATA

Scan no.	Contamination radiation level*	Decontamination radiation level*	Activity removed (%)
1	31.5	5.15	83.7
2	15.2	4.40	71.1
3	24.0	4.74	80.3
4	16.1	4.32	73.2
5	14.6	5.77	60.5
6	48.0	4.02	91.6
7	26.1	3.35	87.2
8	15.8	5.21	67.2
9	16.7	3.36	79.9
10	50.9	3.56	93.0
AVERAGE	24.3 ±7.1		78.8 ±6.2

* Values are proportional to the radiation intensity.

TABLE E-26b

TEST-PLOT DECONTAMINATION DATA

29 Dec 1961

EQUIPMENT Motor Grader
Temperature (°F)
Air 9 Surface 14
Median Time of:
Contamination 1342
Decontamination 1345
Time to Decontaminate 4.40 min

SURFACE Packed Snow
(Second Decontamination)
Contamination Level ______ μc/gm
Deposition Level ______ gm/ft^2
Activity Level ______ mc/ft^2
Dose Rate to Operator 5 mr/hr
Operator Time 0.073 man-hours

SCANNER DATA

Scan no.	Contamination radiation level*	Decontamination radiation level*	Activity removed (%)
1	31.5	11.11	64.7
2	15.2	2.83	81.4
3	24.0	2.68	88.8
4	16.1	2.15	86.6
5	14.6	2.88	80.3
6	48.0	2.86	94.0
7	26.1	2.30	91.2
8	15.8	4.36	72.4
9	16.7	2.77	83.4
10	50.9	3.43	92.9
AVERAGE	24.3 ±7.1		83.6 ±5.4

* Values are proportional to the radiation intensity.

REMARKS: 1. Since the simulant had been partially removed by the first decontamination, the deposition level was not known.

2. The operator time and efficiency index are based on total time for two decontaminations.

TABLE E-27

TEST-PLOT DECONTAMINATION DATA

5 Jan 1962

EQUIPMENT Motor Grader SURFACE Packed Snow

Temperature (°F)
Air 26 Surface 26

Median Time of:
Contamination 1554
Decontamination 1628

Time to Decontaminate 8.00 min

Contamination Level - μc/gm
Deposition Level - gm/ft^2
Activity Level - mc/ft^2
Dose Rate to Operator 10 mr/hr
Operator Time 0.133 man-hours

SCANNER DATA

Scan no.	Contamination radiation level*	Decontamination radiation level*	Activity removed (%)
1	18.1	2.23	87.7
2	25.5	2.34	90.8
3	21.1	2.68	87.3
4	19.3	1.66	91.4
5	22.5	1.87	91.7
6	21.9	1.24	94.3
7	18.2	1.21	93.4
8	14.8	0.99	93.3
9	14.3	0.92	93.6
10	12.4	0.96	92.3
AVERAGE	18.8 ±2.4		91.6 ±1.4

* Values are proportional to the radiation intensity.

REMARKS: The contamination and deposition levels were not measured. Two cuts were made with blade scrapper.

TABLE E-28

TEST-PLOT DECONTAMINATION DATA

20 Jan 1962

EQUIPMENT Fire Hosing SURFACE Packed Snow

Temperature (°F)		Contamination Level	9.3 μc/gm
Air -1	Surface -6	Deposition Level	55.6 gm/ft^2
Median Time of:		Activity Level	0.517 mc/ft^2
Contamination	1006	Dose Rate to Operator	6 mr/hr
Decontamination	1045	Operator Time	1.000 man-hours
Time to Decontaminate	15.00 min		

SCANNER DATA

Scan no.	Contamination radiation level*	Decontamination radiation level*	Activity removed (%)
1	22.8	5.36	76.5
2	20.8	5.70	72.6
3	27.2	9.23	66.1
4	27.4	7.28	73.4
5	24.1	2.61	89.2
6	33.9	3.72	89.0
7	25.7	3.58	86.1
8	22.1	7.92	64.2
9	28.6	9.18	67.9
10	29.5	6.43	78.2
AVERAGE	26.2 ±2.2		76.3 ±5.4

* Values are proportional to the radiation intensity.

REMARKS: 1. Fire hose had a 2.5-inch nozzle with a 1-inch bore.
2. Four men worked simultaneously for 15 minutes.

TABLE E-29

TEST-PLOT DECONTAMINATION DATA

24 Jan 1962

EQUIPMENT Fire Hosing SURFACE Packed Snow

Temperature (°F)
Air 20 Surface 18
Median Time of:
Contamination 0932
Decontamination 1129
Time to Decontaminate 9.00 min

Contamination Level 12.4 ±0.2 μc/gm
Deposition Level 55.9 ±21.1 gm/ft^2
Activity Level 0.693 mc/ft^2
Dose Rate to Operator 7 mr/hr
Operator Time 0.600 man-hours

SCANNER DATA			
Scan no.	Contamination radiation level*	Decontamination radiation level*	Activity removed (%)
1	34.6	7.39	78.7
2	60.9	12.87	78.9
3	51.2	10.00	80.5
4	47.8	9.76	79.6
5	47.7	11.61	75.7
6	51.2	7.58	85.2
7	47.7	8.04	83.1
8	51.5	7.45	85.5
9	47.0	7.24	84.6
10	39.1	6.58	83.2
AVERAGE	47.9 ±4.2		81.5 ±1.9

* Values are proportional to the radiation intensity.

REMARKS: 1. Fire hose had a 2.5-inch nozzle with a 1-inch bore.

2. Four men worked simultaneously for 9 minutes.

TABLE E-30

TEST-PLOT DECONTAMINATION DATA

24 Jan 1962

EQUIPMENT Fire Hosing **SURFACE** Packed Snow

Temperature (°F)
Air 33 Surface 28
Median Time of:
Contamination 1315
Decontamination 1357
Time to Decontaminate 12.50 min

Contamination Level 10.6 ±0.7 μc/gm
Deposition Level 41.4 ±10.5 gm/ft^2
Activity Level 0.438 mc/ft^2
Dose Rate to Operator 8 mr/hr
Operator Time 0.833 man-hours

SCANNER DATA			
Scan no.	Contamination radiation level*	Decontamination radiation level*	Activity removed (%)
1	39.4	2.16	94.5
2	38.4	2.83	92.6
3	42.8	2.81	93.4
4	47.3	3.50	92.6
5	40.2	4.99	87.6
6	43.9	5.61	87.2
7	41.3	4.22	89.8
8	41.2	4.70	88.6
9	45.8	6.43	86.0
10	32.7	7.67	76.6
AVERAGE	41.3 ±2.4		88.9 ±3.0

* Values are proportional to the radiation intensity.

REMARKS: 1. Fire hose had a 2.5-inch nozzle with a 1-inch bore.
2. Four men worked simultaneously for 12.5 minutes.

TABLE E-31

TEST-PLOT DECONTAMINATION DATA

25 Jan 1962

EQUIPMENT Rotary Broom Sweeper SURFACE Packed Snow

Temperature (°F)

Air 37 Surface 32

Median Time of:

Contamination 1125

Decontamination 1156

Time to Decontaminate 1.20 min

Contamination Level 11.5 ±0.7 μc/gm

Deposition Level 40.3 ±28.8 gm/ft^2

Activity Level 0.463 mc/ft^2

Dose Rate to Operator 50 mr/hr

Operator Time 0.020 man-hours

SCANNER DATA			
Scan no.	Contamination radiation level*	Decontamination radiation level*	Activity removed (%)
1	47.2	17.3	63.3
2	45.7	12.7	72.2
3	68.3	7.4	89.2
4	53.3	9.8	81.6
5	52.0	22.3	57.1
6	49.1	5.3	89.2
7	57.6	5.0	91.3
8	44.4	14.0	68.5
9	47.9	4.5	90.6
10	53.6	2.5	95.3
AVERAGE	51.9 ±4.0		79.8 ±7.8

* Values are proportional to the radiation intensity.

TABLE E-32

TEST-PLOT DECONTAMINATION DATA

18 Jan 1962

EQUIPMENT Motor Grader
Temperature (°F)
Air -1 Surface -5
Median Time of:
Contamination 1332
Decontamination 1633
Time to Decontaminate 3.33 min

SURFACE Loose Snow over Packed Snow
(Second Decontamination)
Contamination Level 9.8 ±0.2 μc/gm
Deposition Level 50.0 ±25.3 gm/ft^2
Activity Level 0.491 mc/ft^2
Dose Rate to Operator 10 mr/hr
Operator Time 0.056 man-hours

SCANNER DATA

Scan no.	Contamination radiation level*	Decontamination radiation level*	Activity removed (%)
1	38.1	6.17	83.8
2	33.6	4.32	87.1
3	34.4	4.81	86.0
4	48.0	3.31	93.1
5	41.3	3.34	91.9
6	38.4	2.64	93.1
7	41.9	2.67	93.6
8	33.9	2.73	91.9
9	31.9	4.89	84.7
AVERAGE	37.9 ±3.2		89.5 ±2.4

* Values are proportional to the radiation intensity.

REMARKS: Motor grader was used on this plot after blade snow plow failed to remove the simulant.

Decontamination percentages and times are based only on motor grading phase.

TABLE E-33

TEST-PLOT DECONTAMINATION DATA

6 Jan 1962

EQUIPMENT	Motor Grader	SURFACE	Loose Snow over Packed Snow
Temperature (°F) Air 18	Surface 20	Contamination Level	13.5 ±1.0 μc/gm
Median Time of:		Deposition Level	50.5 ±22.2 gm/ft²
Contamination	1028	Activity Level	0.679 mc/ft²
Decontamination	1113	Dose Rate to Operator	30 mr/hr
Time to Decontaminate	6.00 min	Operator Time	0.100 man-hours

SCANNER DATA			
Scan no.	Contamination radiation level*	Decontamination radiation level *	Activity removed (%)
1	17.2	4.27	75.2
2	32.0	12.81	60.1
3	39.1	9.29	76.2
4	38.6	11.00	71.5
5	43.9	15.72	64.2
6	45.1	19.39	57.0
7	42.7	21.06	50.7
8	40.0	17.37	56.6
9	41.2	19.52	52.6
10	42.4	15.36	63.8
AVERAGE	38.2 ±4.8		62.8 ±5.3

* Values are proportional to the radiation intensity.

REMARKS: This was the operator's first experience with this type of test.

TABLE E-34

TEST-PLOT DECONTAMINATION DATA

18 Jan 1962

EQUIPMENT Blade Snow Plow

Temperature (°F)

Air -2 Surface -1

Median Time of:

Contamination 1147

Decontamination 1334

Time to Decontaminate 0.40 min

SURFACE Loose Snow over Packed Snow

Contamination Level 9.8 ±0.2 μc/gm

Deposition Level 50.0 ±25.3 gm/ft^2

Activity Level 0.491 mc/ft^2

Dose Rate to Operator 10 mr/hr

Operator Time 0.007 man-hours

SCANNER DATA			
Scan no.	Contamination radiation level*	Decontamination radiation level*	Activity removed (%)
1	43.5	41.2	5.3
2	52.5	38.1	27.4
3	62.1	33.6	46.1
4	36.4	34.4	5.5
5	54.2	48.0	11.4
6	43.5	41.3	5.1
7	42.9	38.4	10.5
8	44.0	41.9	4.8
9	43.8	33.9	22.5
10	39.8	31.9	19.9
AVERAGE	46.3 ±4.4		15.9 ±7.8

* Values are proportional to the radiation intensity.

REMARKS: The "loose" snow was frozen solid. The blade could not penetrate the surface.

TABLE E-35

TEST-PLOT DECONTAMINATION DATA

10 Jan 1962

EQUIPMENT Motor Grader

Temperature (°F)

Air 1 Surface 0

Median Time of:

Contamination 1514

Decontamination 1548

Time to Decontaminate 1.75 min

SURFACE Undisturbed Snow

Contamination Level 5.9 ±0.3 μc/gm

Deposition Level 49.8 ±13.0 gm/ft^2

Activity Level 0.294 mc/ft^2

Dose Rate to Operator 7 mr/hr

Operator Time 0.029 man-hours

SCANNER DATA			
Scan no.	Contamination radiation level*	Decontamination radiation level*	Activity removed (%)
1	13.2	4.33	67.2
2	15.9	5.97	62.5
3	17.6	7.10	59.7
4	19.0	8.18	56.9
5	25.2	8.36	66.8
6	22.2	6.66	70.0
7	21.3	7.52	64.7
8	25.9	8.16	68.5
9	22.7	8.48	62.6
10	21.9	7.99	63.5
AVERAGE	20.5 ±2.4		64.2 ±2.3

* Values are proportional to the radiation intensity.

TABLE E-36a

TEST-PLOT DECONTAMINATION DATA

30 Dec 1961

EQUIPMENT Motor Grader SURFACE Undisturbed Snow

Temperature (°F)

Air 18 Surface 19

Median Time of:

Contamination 1621

Decontamination 1645

Time to Decontaminate 5.00 min

Contamination Level 7.6 ±3.1 μc/gm

Deposition Level 53.4 ±11.2 gm/ft^2

Activity Level 0.407 mc/ft^2

Dose Rate to Operator 8 mr/hr

Operator Time 0.083 man-hours

SCANNER DATA			
Scan no.	Contamination radiation level*	Decontamination radiation level*	Activity removed (%)
1	15.6	7.13	54.3
2	15.3	8.46	44.7
3	21.8	8.73	59.9
4	24.3	11.31	53.5
5	24.8	10.71	56.8
6	23.0	10.19	55.7
7	24.2	11.08	54.2
8	21.9	9.81	55.2
9	22.2	10.69	51.9
AVERAGE	21.4 ±2.0		54.0 ±2.6

* Values are proportional to the radiation intensity.

REMARKS: This was the operator's first experience with this type of test.

TABLE E-36b

TEST-PLOT DECONTAMINATION DATA (ACROSS PLOT)

30 Dec 1961

EQUIPMENT Grader SURFACE Undisturbed Snow

Temperature (°F)
Air 18 Surface 19

SCANNER DATA			
Scan no.	Contamination radiation level*	Decontamination radiation level*	Activity removed (%)
a	0.70	0.51	27.6
b	1.28	.58	54.6
c	1.63	.69	57.7
d	1.68	1.11	33.9
e	1.63	1.04	36.0
f	1.55	.56	63.6
g	1.35	.49	63.6
h	1.28	.80	37.8
i	1.55	1.23	20.6
j	1.75	.84	51.8
k	1.75	.62	64.5
l	1.72	.37	78.4
m	1.47	.27	81.4
n	0.70	.24	65.4

* Values are proportional to radiation intensity.

REMARKS: Scans a through n obtained from one middle scan of table 36a.

TABLE E-37a

TEST-PLOT DECONTAMINATION DATA

18 Jan 1962

EQUIPMENT Blade Snow Plow
Temperature (°F)
Air 2 Surface 0
Median Time of:
Contamination 1450
Decontamination 1510
Time to Decontaminate 0.33 min

SURFACE Undisturbed Snow
Contamination Level 9.0 ±0.3 μc/gm
Deposition Level 57.3 ±12.7 gm/ft²
Activity Level 0.517 mc/ft²
Dose Rate to Operator 12 mr/hr
Operator Time 0.006 man-hours

SCANNER DATA			
Scan no.	Contamination radiation level*	Decontamination radiation level*	Activity removed (%)
1	39.0	1.18	97.0
2	31.6	1.34	95.8
3	38.7	1.62	95.8
4	41.6	1.66	96.0
5	38.3	1.95	94.9
6	43.2	1.77	95.9
7	40.4	2.00	95.1
8	37.4	1.90	94.9
9	40.8	1.78	95.6
10	34.9	2.36	93.2
AVERAGE	38.6 ±2.0		95.4 ±0.6

* Values are proportional to the radiation intensity.

TABLE E-37b

TEST-PLOT DECONTAMINATION DATA (SCANNER DATA ACROSS PLOT)

18 Jan 1962

EQUIPMENT Blade Snow Plow SURFACE Undisturbed Snow

Temperature (°F)

Air 2 Surface 0

SCANNER DATA			
Scan no.	Contamination radiation level*	Decontamination radiation level*	Activity removed (%)
a	1.25	0.19	85.2
b	2.32	.17	92.7
c	2.82	.17	94.0
d	2.80	.15	94.7
e	2.80	.14	95.1
f	2.75	.19	93.1
g	2.68	.19	92.9
h	2.38	.17	92.9
i	2.88	.20	93.2
j	3.18	.13	96.0
k	3.02	.10	96.8
l	2.80	.10	96.6
m	2.80	.10	97.1
n	2.58	.10	96.9

* Values are proportional to radiation intensity.

REMARKS: Scans a through n obtained from one middle scan of table 37a.

TABLE E-38

TEST-PLOT DECONTAMINATION DATA

18 Jan 1962

EQUIPMENT Rotary Snow Plow SURFACE Undisturbed Snow

Temperature (°F)

Air -1 Surface -2

Median Time of:

Contamination 1534

Decontamination 1604

Time to Decontaminate 2.18 min

Contamination Level 9.1 ±2.6 μc/gm

Deposition Level 53.2 ±21.4 gm/ft^2

Activity Level 0.483 mc/ft^2

Dose Rate to Operator 13 mr/hr

Operator Time 0.036 man-hours

SCANNER DATA				
Scan no.	Contamination radiation level*	Decontamination radiation level*	Activity removed (%)	
1	44.4	4.34	90.2	
2	36.7	6.55	82.2	
3	43.4	6.53	85.0	
4	42.5	6.93	83.7	
5	33.3	6.08	81.7	
6	40.9	5.97	85.4	
7	34.9	6.74	80.7	
8	35.0	6.56	81.3	
9	37.3	7.25	80.6	
10	32.9	7.35	77.7	
AVERAGE	38.1 ±2.6		82.9 ±2.0	

* Values are proportional to the radiation intensity.

TABLE E-39

TEST-PLOT DECONTAMINATION DATA

25 Jan 1962

EQUIPMENT Towed Scraper SURFACE Undisturbed Snow

Temperature (°F)
Air 29 Surface 24
Median Time of:
Contamination 0934
Decontamination 1005
Time to Decontaminate 1.60 min

Contamination Level 12.0 μc/gm
Deposition Level 42.3 gm/ft^2
Activity Level 0.508 mc/ft^2
Dose Rate to Operator 12 mr/hr
Operator Time 0.027 man-hours

SCANNER DATA			
Scan no.	Contamination radiation level*	Decontamination radiation level*	Activity removed (%)
1	46.9	2.08	95.6
2	48.7	1.92	96.1
3	50.4	2.36	95.3
4	62.4	4.60	92.6
5	57.2	9.32	83.7
6	59.3	9.44	84.1
7	52.4	9.79	81.3
8	53.4	9.88	81.5
9	59.4	10.58	82.2
10	49.7	13.67	72.5
AVERAGE	54.0 ±0.4		86.5 ±4.6

* Values are proportional to the radiation intensity.

TABLE E-40

TEST-PLOT DECONTAMINATION DATA

17 Jan 1962

EQUIPMENT Fire Hosing SURFACE Bare Roof

Temperature (°F)

Air -7 Surface -4

Median Time of:

Contamination 1430

Decontamination 1335 (1-19-62)

Time to Decontaminate 7.00 min

Contamination Level - μc/gm

Deposition Level - gm/ft^2

Activity Level - mc/ft^2

Dose Rate to Operator 2 mr/hr

Operator Time 0.467 man-hours

SCANNER DATA			
Scan no.	Contamination radiation level	Decontamination radiation level	Activity removed (%)
1	43.8 mr/hr	23.5 mr/hr	46.4
2	51.2	28.5	44.3
3	45.6	27.0	40.8
4	50.0	29.0	42.0
5	48.9	28.0	42.8
6	42.9	26.0	39.4
7	42.5	25.0	41.2
8	54.5	28.0	48.6
9	41.6	28.0	32.7
AVERAGE	46.8 ± 7.4		42.0 ±7.4

REMARKS:

1. Surface area was 1000 square feet.
2. Fire hose had a 1.5-inch nozzle with an 0.75-inch bore.
3. Four men worked simultaneously for 7 minutes.
4. Survey values (scanner data) were made with an Eberline E-200 survey meter at a probe height of 2.5 feet.

TABLE E-41

TEST-PLOT DECONTAMINATION DATA

6 Feb 1962

EQUIPMENT Fire Hosing SURFACE Bare Roof (warm)

Temperature (°F)

Air 2 Surface 14

Median Time of:

Contamination 1330

Decontamination 1430

Time to Decontaminate 3.00 min

Contamination Level - μc/gm

Deposition Level - gm/ft²

Activity Level - mc/ft²

Dose Rate to Operator 5 mr/hr

Operator Time 0.200 man-hours

SCANNER DATA			
Scan no.	Contamination radiation level	Decontamination radiation level	Activity removed (%)
	mr/hr	mr/hr	
1	2.94	1.2	59.2
2	2.94	1.6	45.6
3	2.45	1.0	59.2
4	2.20	0.8	63.6
5	1.96	0.7	64.3
6	1.96	0.5	74.5
7	2.75	0.7	74.6
8	2.50	1.0	60.0
9	2.50	0.7	72.0
10	2.00	0.5	75.0
11	2.00	0.6	70.0
AVERAGE	2.38 ±0.63		65.3 ±15.0

REMARKS:
1. Surface area was 2000 square feet.
2. Fire hose had a 2.5-inch nozzle with a 1-inch bore.
3. Four men worked simultaneously for 3 minutes.
4. Survey values (scanner data) were made with an Eberline E-200 survey meter at a probe height of 2.5 feet.

TABLE E-42

TEST-PLOT DECONTAMINATION DATA

6 Jan 1962

EQUIPMENT	Fire Hosing	SURFACE	Bare Roof
Temperature (°F)			
Air 21 Surface	24	Contamination Level	- μc/gm
Median Time of:		Deposition Level	- gm/ft^2
Contamination	1330	Activity Level	- mc/ft^2
Decontamination	1430	Dose Rate to Operator	5 mr/hr
Time to Decontaminate	7.75 min	Operator Time	0.517 man-hours

SCANNER DATA

Scan no.	Contamination radiation level	Decontamination radiation level	Activity removed (%)
	mr/hr	mr/hr	
1	105	35.6	70.5
2	93	42.3	78.0
3	91	50.9	44.1
4	120	55.9	53.4
5	105	45.8	56.4
6	115	30.5	73.5
7	115	28.5	75.2
8	100	19.8	80.2
9	100	14.7	85.3
AVERAGE	105 ±17		68.5 ±22.9

REMARKS:
1. Surface area was 600 square feet.
2. Four men worked simultaneously for 7.75 minutes.
3. Fire hose had a 1.5-inch fog nozzle with an adjustable bore.
4. Survey values (scanner data) were made with an Eberline E-200 survey meter at a probe height of 2.5 feet.

APPENDIX F

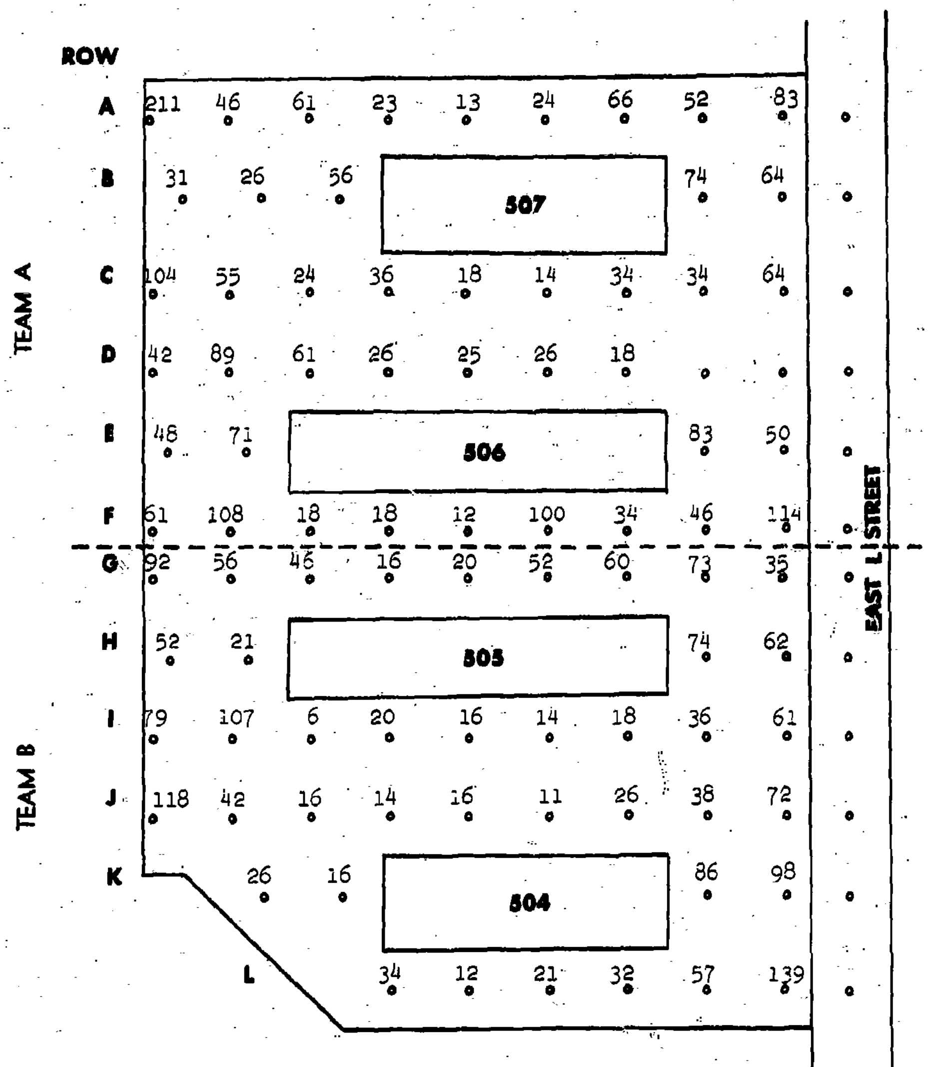
LOGISTICS EXERCISE DECONTAMINATION DATA

Figure F-1 shows the two test-area sectors and the portion decontaminated by each team. The numbers appearing on this figure, and on those of the roofs and interiors of the buildings (figures F-2 through F-6), indicate the effectiveness of the decontamination operations. These numbers also appear in tables F-1 through F-16 along with the contamination and decontamination readings from which they were derived:

$$\% \text{ Activity Remaining} = \frac{\text{Decontamination Reading}}{\text{Contamination Reading}} \times 100$$

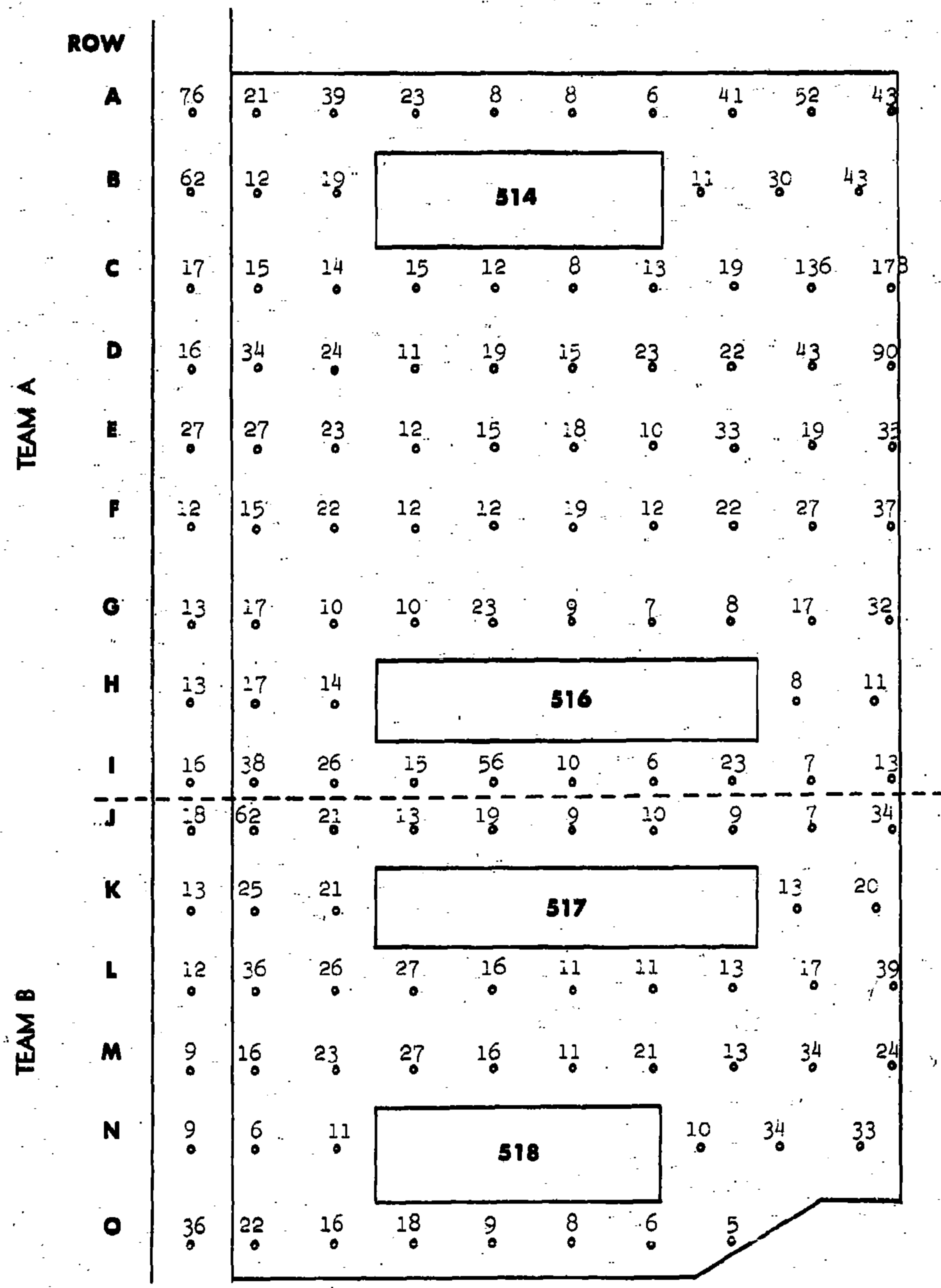
The locations of the numbers on the figures approximate those where the instrument readings were made.

FIGURE F-1 PERCENT ACTIVITY REMAINING ON GROUND COMPLEX AFTER DECONTAMINATION



Sector I

NPC 16,605



Sector II

BUILDING 506

BOTTOM	22	23	20	19	20	21	16	20	19	24	23
	20	14	19	16	14	13	13	14	15	17	21
TOP											
	17	13	16	17	16	17	x	21	13	16	18
BOTTOM	21	22	23	15	23	23	20	18	x	22	32

FRONT

BUILDING 505

BOTTOM	18	14	17	15	15	16	13	15	23	17	17
	17	15	16	16	16	14	12	14	15	16	18
TOP											
	15	12	15	14	15	15	16	18	19	25	24
BOTTOM	12	13	13	15	15	15	15	18	21	23	28

FRONT

FIGURE F-2 PERCENT ACTIVITY REMAINING ON ROOFS AFTER DECONTAMINATION: SECTOR I

BUILDING 516

FRONT

18	23	19	23	23	20	20	19	22	20	22	18	BOTTOM
18	22	19	15	16	20	16	18	16	16	17	13	TOP
18	21	20	27	13	14	17	17	22	21	19	15	
21	26	26	22	16	24	22	22	22	24	22	24	BOTTOM

BUILDING 517

FRONT

22	16	20	26	21	18	15	15	14	11	12	10	9	BOTTOM
17	19	16	17	14	13	14	14	15	12	11	11	10	TOP
17	20	18	14	16	15	21	18	18	19	18	16	12	
20	23	20	23	18	18	21	19	24	21	21	21	19	BOTTOM

FIGURE F-3 PERCENT ACTIVITY REMAINING ON ROOFS AFTER DECONTAMINATION: SECTOR II

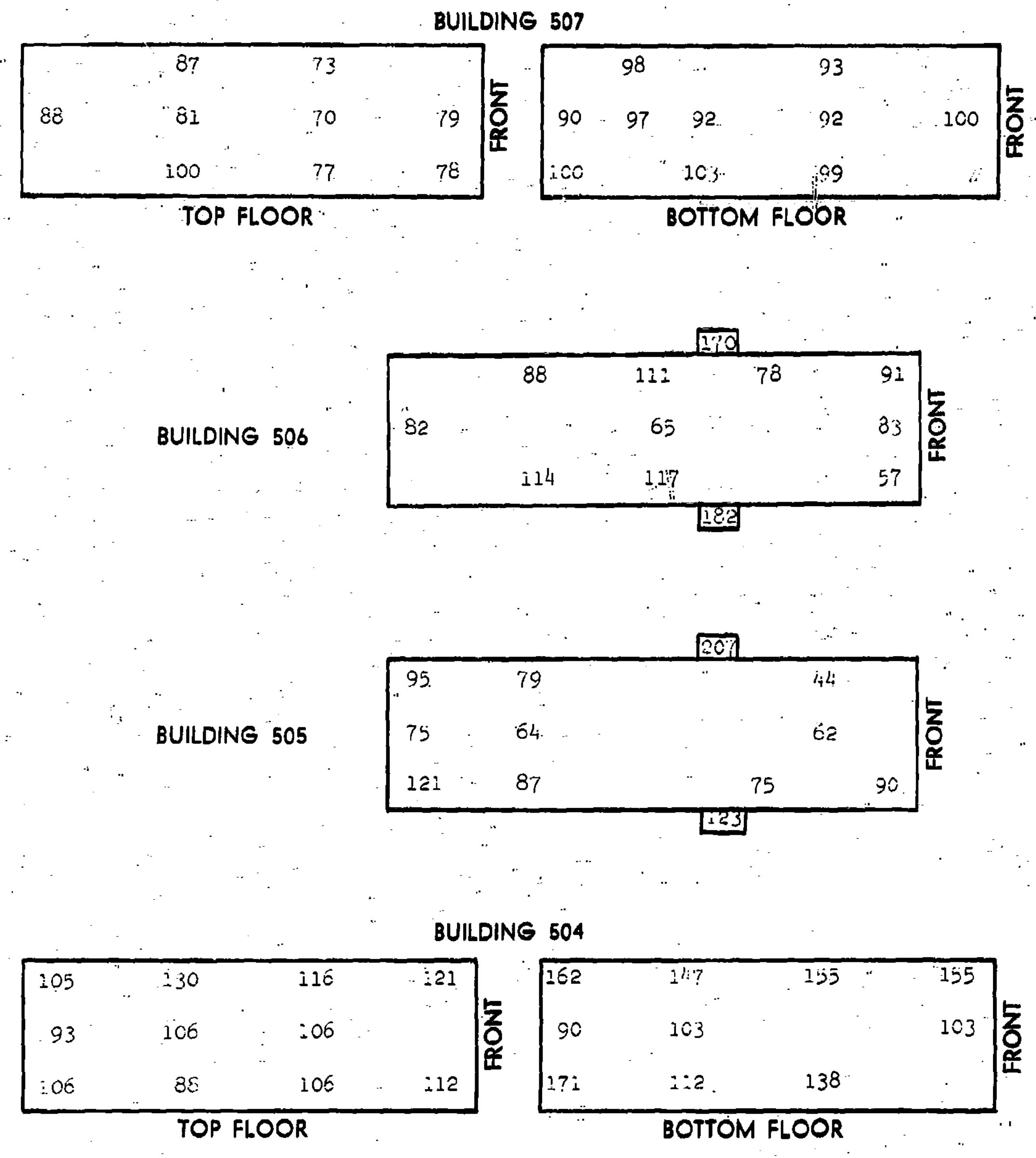


FIGURE F-4 PERCENT RADIATION REMAINING INSIDE BUILDINGS AFTER ROOF DECONTAMINATION: SECTOR I

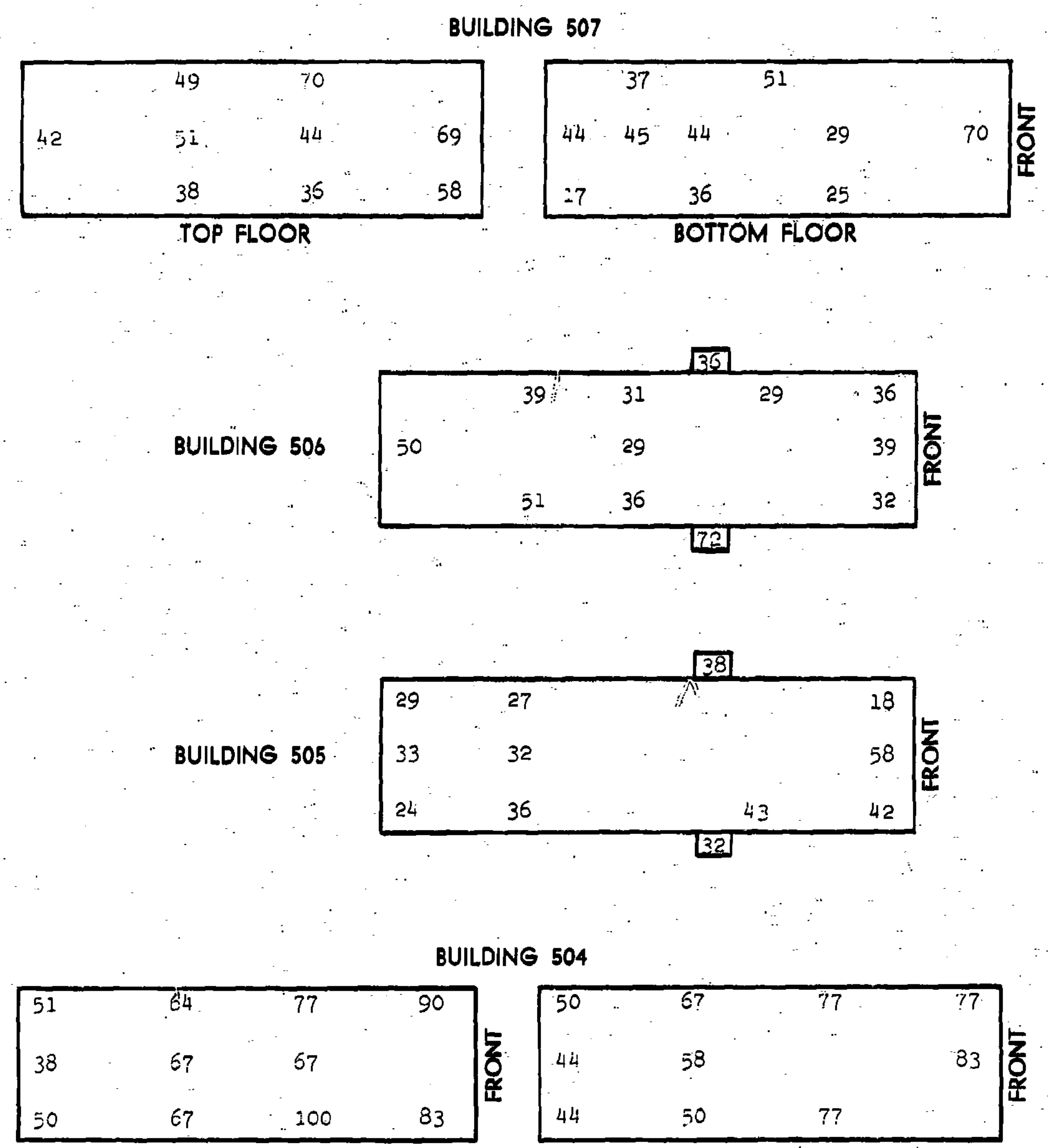


FIGURE F-5 PERCENT RADIATION REMAINING INSIDE BUILDINGS AFTER ROOF AND GROUND DECONTAMINATION: SECTOR I

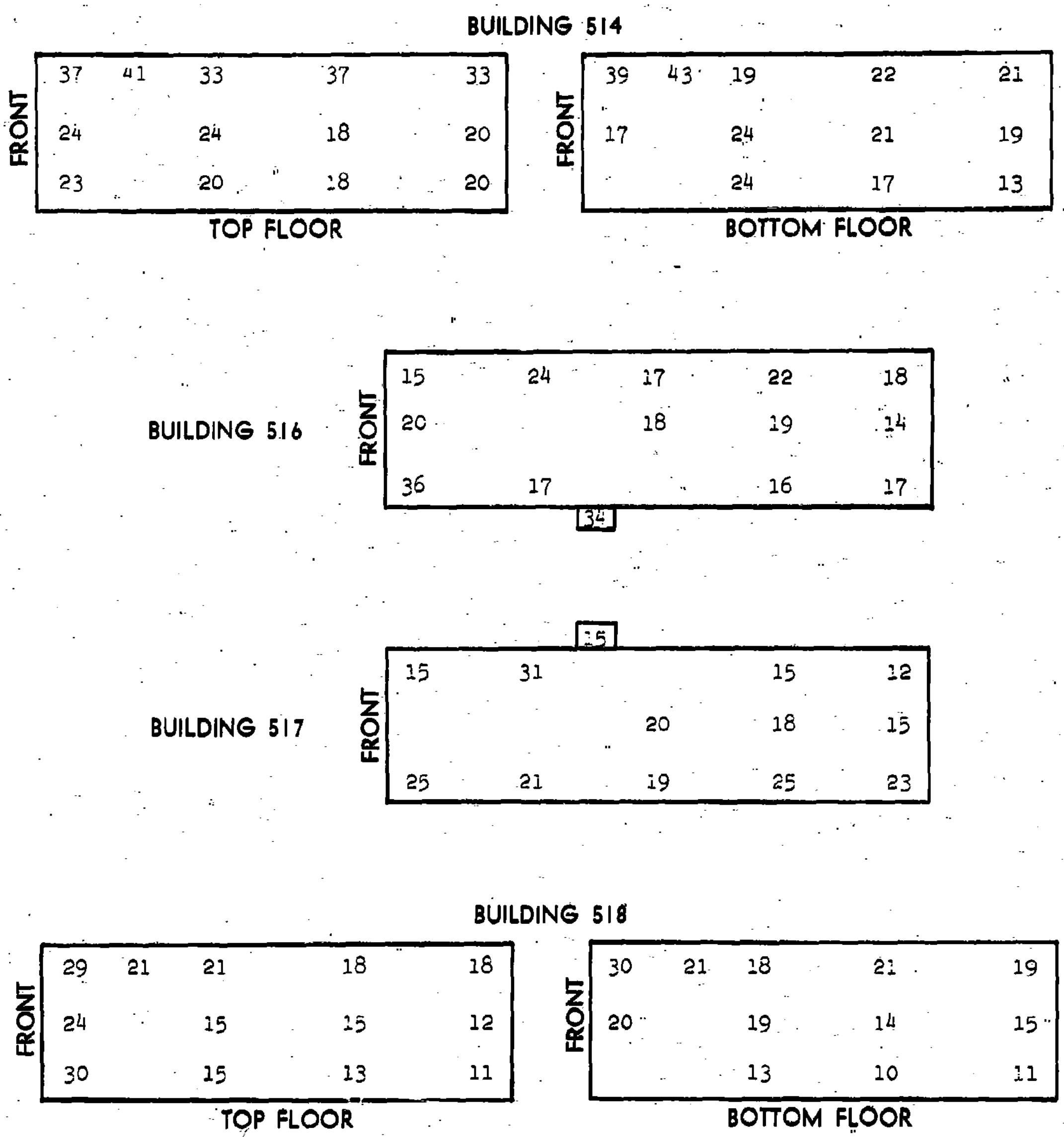


FIGURE F-6 PERCENT RADIATION REMAINING INSIDE BUILDINGS AFTER ROOF AND GROUND DECONTAMINATION: SECTOR II

TABLE F-1

LOGISTICS EXERCISE DECONTAMINATION DATA

SECTOR I

Ground Complex — Team A

Time of Measurements

Contamination 1635 (31 Jan 62)

Decontamination 1855 (1 Feb 62)

Temperature 50°F

Man-hours/1000 ft^2 0.33

Time to Decontaminate 180 min

Instrument Data*								
Contamination (mr/hr)	Decontamination (mr/hr)	% Activity Remaining†	Contamination (mr/hr)	Decontamination (mr/hr)	% Activity Remaining†	Contamination (mr/hr)	Decontamination (mr/hr)	% Activity Remaining†
Row A			Row B			Row C		
1.9	4.0	211	15.2	4.7	31	12.0	12.5	104
7.6	3.5	46	19.0	5.0	26	14.6	8.0	55
5.7	3.5	61	4.5	2.5	56	19.0	4.5	24
8.8	2.0	23				12.5	4.5	36
19.0	2.5	13				22.0	4.0	18
14.5	3.5	24				25.2	3.5	14
11.4	7.5	66				19.0	6.5	34
22.0	11.5	52	15.6	11.5	74	25.2	8.5	34
11.4	9.5	83	15.6	10.0	64	22.0	14.0	64
Row D			Row E			Row F		
10.8	4.5	42	11.4	5.5	48	11.4	7.0	61
10.1	9.0	89	7.0	5.0	71	8.8	9.5	108
13.9	8.5	61				22.0	4.0	18
19.0	5.0	26				22.0	4.0	18
22.0	5.5	25				25.2	3.0	12
19.0	5.0	26				19.0	19.0	100
38.0	7.0	18				19.0	6.5	34
			10.2	8.5	83	25.2	11.5	46
			25.2	12.5	50	15.8	18.0	114

*Dose rates were measured 3 feet above the ground at the center of 25-foot squares with the Nuclear Chicago "Cutie Pie" No. 2586. All readings have been corrected for decay.

†See Figure F-1 for geographic location of instrument readings.

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TABLE F-2

LOGISTICS EXERCISE DECONTAMINATION DATA

SECTOR I

Ground Complex | Team B

Time of Measurements

Contamination 1635 (31 Jan 62)
Decontamination 1855 (1 Feb 62)

Temperature 50°F
Man-hours/1000 ft^2 1.19
Time to Decontaminate 216 min

Instrument Data*								
Contamination (mr/hr)	Decontamination (mr/hr)	% Activity Remaining†	Contamination (mr/hr)	Decontamination (mr/hr)	% Activity Remaining†	Contamination (mr/hr)	Decontamination (mr/hr)	% Activity Remaining†
Row G			Row H			Row I		
12.0	11.0	92	14.5	7.5	52	6.3	5.0	79
10.8	6.0	56	19.0	4.0	21	7.0	7.5	107
7.6	3.5	46				70.0	4.0	6
15.8	2.5	16				10.1	2.0	20
12.5	2.5	20				12.5	2.0	16
12.5	6.5	52				14.5	2.0	14
10.8	6.5	60				19.0	3.5	18
41.0	30.0	73	19.0	14.0	74	22.0	8.0	36
28.5	10.0	35	25.2	15.5	62	22.0	13.5	61
Row J			Row K			Row L		
3.8	4.5	118	11.4	3.0	26			
9.5	4.0	42	15.8	2.5	16			
28.5	4.5	16				22.0	7.5	34
22.0	3.0	14				12.5	1.5	12
19.0	3.0	16				12.0	2.5	21
19.0	2.0	11				17.2	5.5	32
17.1	4.5	26	7.0	6.0	86	15.8	9.0	57
15.8	6.0	38	15.8	15.5	98	10.1	14.0	139
20.8	15.0	72						

*Dose rates were measured 3 feet above the ground at the center of 25-foot squares with the Nuclear Chicago "Cutie Pie" No. 2586. All readings have been corrected for decay.

†See Figure F-1 for geographic location of instrument readings.

TABLE F-3

LOGISTICS EXERCISE DECONTAMINATION DATA

SECTOR II

Ground Complex

Team A

Time of Measurements

Contamination 1520 (1 Feb 62)

Decontamination 1535 (2 Feb 62)

Temperature 26°F

Man-hours/1000 ft^2 0.27

Time to Decontaminate 300 min

Instrument Data*

Contamination (mr/hr)	Decontamination (mr/hr)	% Activity Remaining†	Contamination (mr/hr)	Decontamination (mr/hr)	% Activity Remaining†	Contamination (mr/hr)	Decontamination (mr/hr)	% Activity Remaining†
	Row A			Row B			Row C	
3.3	2.5	76	6.6	4.1	62	26.5	4.6	17
19.8	4.2	21	19.7	2.3	12	23.0	3.5	15
10.0	3.9	39	13.2	2.5	19	36.5	5.0	14
14.9	3.5	23				39.6	5.9	15
29.8	2.5	8				29.8	3.5	12
26.6	2.0	8				33.0	2.5	8
23.2	1.5	6				36.5	4.8	13
8.3	3.4	41	9.3	1.0	11	16.5	3.2	19
2.3	1.2	52	7.9	2.4	30	3.3	4.5	136
2.3	1.0	43	2.3	1.0	43	2.3	4.1	178
	Row D			Row E			Row F	
46.2	7.6	16	29.6	8.0	27	46.4	5.7	12
26.5	9.0	34	16.6	4.5	27	26.5	4.0	15
33.0	8.0	24	29.6	6.8	23	23.2	5.2	22
43.0	4.8	11	29.6	3.7	12	33.2	4.0	12
33.0	6.4	19	36.4	5.6	15	36.3	4.5	12
23.0	3.5	15	19.8	3.5	18	26.5	5.1	19
19.5	4.5	23	29.6	3.0	10	36.3	4.5	12
23.0	5.0	22	15.2	5.0	33	23.2	5.1	22
11.3	4.9	43	23.2	4.3	19	26.5	7.2	27
3.9	3.5	90	9.9	3.5	35	16.6	6.1	37

*Dose rates were measured 3 feet above the ground at the center of 25-foot squares with the Nuclear Chicago "Cutie Pie" No. 2586. All readings have been corrected for decay.

†See Figure F-1 for geographic location of instrument readings.

TABLE F-3 (cont'd)

LOGISTICS EXERCISE DECONTAMINATION DATA

SECTOR II

Ground Complex | **Team A**

Time of Measurements

Contamination 1520 (1 Feb 62)

Decontamination 1535 (2 Feb 62)

Temperature 26°F

Man-hours/1000 ft^2 0.27

Time to Decontaminate 300 min

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Instrument Data*								
Contamination (mr/hr)	Decontamination (mr/hr)	% Activity Remaining†	Contamination (mr/hr)	Decontamination (mr/hr)	% Activity Remaining†	Contamination (mr/hr)	Decontamination (mr/hr)	% Activity Remaining†
	Row G			Row H			Row I	
33.0	4.3	13	39.6	5.0	13	46.2	7.5	16
29.6	5.0	17	29.6	5.0	17	29.6	11.2	38
44.0	4.5	10	33.0	4.5	14	23.0	6.0	26
44.0	4.5	10				23.0	3.5	15
13.2	3.0	23				9.9	5.5	56
29.6	2.6	9				29.6	2.9	10
33.0	2.3	7				36.3	2.3	6
36.3	3.0	8				10.5	2.4	23
36.3	6.2	17	26.5	2.0	8	43.0	2.8	7
19.8	6.4	32	26.5	3.0	11	15.8	2.0	13

TABLE F-4

LOGISTICS EXERCISE DECONTAMINATION DATA

SECTOR II

Ground Complex | **Team B**

Time of Measurements

Contamination 1520 (1 Feb 62)
Decontamination 1535 (2 Feb 62)

Temperature 26°F
Man-hours/1000 ft^2 1.93
Time to Decontaminate 300 min

Instrument Data*								
Contamination (mr/hr)	Decontamination (mr/hr)	% Activity Remaining†	Contamination (mr/hr)	Decontamination (mr/hr)	% Activity Remaining†	Contamination (mr/hr)	Decontamination (mr/hr)	% Activity Remaining†
Row J			Row K			Row L		
39.6	7.2	18	43.0	5.6	13	39.6	4.8	12
13.2	8.2	62	23.0	5.7	25	19.7	7.0	36
26.5	5.6	21	19.7	4.1	21	19.7	5.2	26
23.0	3.0	13				16.5	4.5	27
13.2	2.5	19				23.0	3.6	16
29.6	2.6	9				23.0	2.5	11
23.0	2.4	10				26.5	3.0	11
23.0	2.0	9				23.0	3.1	13
33.0	2.3	7	19.7	2.6	13	23.0	3.8	17
14.5	4.9	34	23.0	4.5	20	10.6	4.1	39
Row M			Row N			Row O		
39.6	3.5	9	49.5	4.5	9	26.5	9.5	36
29.6	4.7	16	49.5	3.0	6	36.5	8.0	22
26.5	6.0	23	26.5	3.0	11	43.0	7.0	16
13.2	3.5	27				19.7	3.5	18
16.5	2.6	16				23.0	2.0	9
23.0	2.5	11				29.6	2.5	8
11.8	2.5	21	23.2	2.4	10	36.2	2.3	6
19.7	2.5	13	14.5	4.9	34	29.6	1.5	5
13.2	4.5	34	15.2	5.0	33			
16.5	4.0	24						

*Dose rates were measured 3 feet above the ground at the center of 25-foot squares with the Nuclear Chicago "Cutie Pie" No. 2586. All readings have been corrected for decay.

†See Figure F-1 for geographic location of instrument readings.

TABLE F-5

LOGISTICS EXERCISE DECONTAMINATION DATA

SECTOR I

Building 506*- Roof

Team A

Time of Measurements

Contamination 1420 (31 Jan 62)
Decontamination 1650 (1 Feb 62)

Temperature 13°F
Man-hours/1000 ft² 0.93
Time to Decontaminate 50 min

Instrument Data**					
Contamination (mr/hr)	Decontamination (mr/hr)	% Activity Remaining†	Contamination (mr/hr)	Decontamination (mr/hr)	% Activity Remaining†
East Side: Top Row			West Side: Top Row		
19.0	4.0	21	21.0	3.7	18
21.0	3.5	17	21.5	3.5	16
23.0	3.5	15	25.5	3.3	13
21.0	3.0	14	15.9	3.3	21
23.5	3.0	13	x	3.3	x
23.5	3.0	13	19.0	3.3	17
19.0	2.7	14	19.0	3.0	16
16.5	2.7	16	15.8	2.7	17
17.8	3.3	19	15.8	2.5	16
17.8	2.5	14	19.0	2.5	13
16.5	3.3	20	19.0	3.3	17
East Side: Bottom Row			West Side: Bottom Row		
19.5	4.5	23	15.8	5.0	32
17.8	4.3	24	19.2	4.3	22
21.0	4.0	19	x	x	x
17.2	3.5	20	22.2	4.0	18
25.6	4.0	16	22.2	4.5	20
16.5	3.5	21	15.8	3.7	23
17.2	3.5	20	14.5	3.3	23
17.2	3.3	19	22.2	3.3	15
16.5	3.3	20	15.8	3.7	23
15.8	3.7	23	15.8	3.5	22
15.8	3.5	22	15.8	3.3	21
Activity Remaining (Avg) = 18%			Activity Remaining (Avg) = 19%		

*Roof decontaminated by sweeping.

**Measurements taken 3 feet above surface with an Eberline E-200A radiation meter. All readings corrected for decay.

† See Figure F-2 for geographic location of readings.

TABLE F-6

LOGISTICS EXERCISE DECONTAMINATION DATA

SECTOR I

Building 505*- Roof Team B

Time of Measurements
Contamination 1450 (31 Jan 62)
Decontamination 1510 (1 Feb 62)

Temperature 19°F
Man-hours/1000 ft^2 1.05
Time to Decontaminate 57 min

Instrument Data**					
Contamination (mr/hr)	Decontamination (mr/hr)	% Activity Remaining†	Contamination (mr/hr)	Decontamination (mr/hr)	% Activity Remaining†
East Side: Top Row			West Side: Top Row		
22.2	4.0	10	19.6	4.7	24
19.0	3.0	16	16.3	4.0	25
17.0	2.5	15	17.6	3.3	19
18.3	2.5	14	17.0	3.0	18
19.0	2.3	12	17.0	2.7	16
13.8	2.0	14	17.0	2.5	15
12.5	2.0	16	16.4	2.5	15
12.5	2.0	16	16.4	2.5	14
12.5	2.0	16	16.4	2.5	15
13.1	2.0	15	17.0	2.0	12
13.7	2.3	17	17.0	2.5	15
East Side: Bottom Row			West Side: Bottom Row		
21.6	3.7	17	17.7	5.0	28
15.7	2.7	17	16.4	3.7	23
11.1	2.5	23	16.4	3.5	21
16.4	2.5	15	17.1	3.1	18
19.6	2.5	13	18.3	2.7	15
14.4	2.3	16	16.3	2.5	15
13.1	2.0	15	16.3	2.5	15
13.1	2.0	15	17.1	2.5	15
13.8	2.3	17	17.6	2.3	13
13.8	2.0	14	18.3	2.3	13
13.8	2.5	18	19.7	2.3	12
Activity Remaining (Avg) = 16%			Activity Remaining (Avg) = 17%		

*Roof decontaminated by sweeping.

**Measurements taken 3 feet above surface with an Eberline E-200A radiation meter. All measurements corrected for decay.

† See Figure F-2 for geographic location of readings.

TABLE F-7

LOGISTICS EXERCISE DECONTAMINATION DATA

SECTOR II

Building 516*- Roof | Team A

Time of Measurements
Contamination 1345 (1 Feb 62)
Decontamination 1710 (2 Feb 62)

Temperature 26°F
Man-hours/1000 ft^2 1.05
Time to Decontaminate 57 min

Instrument Data**					
Contamination (mr/hr)	Decontamination (mr/hr)	% Activity Remaining†	Contamination (mr/hr)	Decontamination (mr/hr)	% Activity Remaining†
East Side: Top Row			West Side: Top Row		
12.5	2.3	18	12.5	2.3	18
10.6	2.3	22	9.4	2.0	21
10.3	2.0	19	10.0	2.0	20
11.2	1.7	15	9.4	2.5	27
10.3	1.6	16	11.9	1.6	13
10.0	2.0	20	10.6	1.5	14
9.4	1.5	16	10.0	1.7	17
9.7	1.7	18	11.6	2.0	17
10.0	1.6	16	10.3	2.3	22
9.7	1.6	16	11.0	2.3	21
10.0	1.7	17	10.3	2.0	19
11.3	1.5	13	15.0	2.3	15
East Side: Bottom Row			West Side: Bottom Row		
12.5	2.3	18	11.9	2.5	21
10.0	2.3	23	8.7	2.3	26
10.3	2.0	19	8.7	2.3	26
10.6	2.3	22	9.1	2.0	22
10.0	2.3	23	17.5	2.8	16
9.7	1.9	20	10.3	2.5	24
10.0	2.0	20	10.6	2.3	22
10.0	1.9	19	10.6	2.3	22
10.3	2.3	22	10.6	2.3	22
10.0	2.0	20	10.6	2.5	24
10.6	2.3	22	11.3	2.5	22
12.8	2.3	18	11.9	2.8	24
Activity Remaining (Avg) = 19%			Activity Remaining (Avg) = 21%		

*Roof decontaminated by sweeping.

**Measurements taken 3 feet above surface with an Eberline E-200A radiation meter. All measurements corrected for decay.

† See Figure F-3 for geographic location of readings.

TABLE F-8

LOGISTICS EXERCISE DECONTAMINATION DATA

SECTOR II

Building 517*- Roof

Team B

Time of Measurements

Contamination 1410 (1 Feb 62)
Decontamination 1730 (2 Feb 62)

Temperature 26°F
Man-hours/1000 ft² 1.48
Time to Decontaminate 80 min

Instrument Data**					
Contamination (mr/hr)	Decontamination (mr/hr)	% Activity Remaining†	Contamination (mr/hr)	Decontamination (mr/hr)	% Activity Remaining†
East Side: Top Row			West Side: Top Row		
10.9	1.9	17	11.5	1.9	17
10.3	2.0	19	10.0	2.0	20
10.3	1.6	16	10.0	1.8	18
10.0	1.7	17	10.0	1.4	14
11.2	1.6	14	10.3	1.6	16
10.6	1.4	13	11.3	1.7	15
10.9	1.5	14	11.9	2.5	21
10.3	1.4	14	10.9	2.0	18
9.4	1.4	15	10.9	2.0	18
11.9	1.4	12	12.2	2.3	19
12.2	1.3	11	11.3	2.0	18
12.2	1.3	11	12.2	2.0	16
14.4	1.5	10	14.4	1.7	12
East Side: Bottom Row			West Side: Bottom Row		
10.6	2.3	22	11.3	2.3	20
10.3	1.6	16	10.0	2.3	23
6.9	1.4	20	11.3	2.3	20
6.9	1.8	26	10.0	2.3	23
7.5	1.6	21	10.9	2.0	18
10.3	1.9	18	11.3	2.0	18
10.9	1.6	15	10.9	2.3	21
10.6	1.6	15	10.6	2.0	19
11.3	1.6	14	10.6	2.5	24
12.2	1.4	11	10.9	2.3	21
12.5	1.5	12	10.9	2.3	21
13.8	1.4	10	9.7	2.0	21
17.5	1.5	9	13.1	2.5	19
Activity Remaining (Avg) = 15%			Activity Remaining (Avg) = 19%		

*Roof decontaminated by sweeping.

**Measurements taken 3 feet above surface with an Eberline E-200A radiation meter. All readings corrected for decay.

† See Figure F-3 for geographic location of readings.

TABLE F-9

LOGISTICS EXERCISE DECONTAMINATION DATA

SECTOR I

Building 507* - Interior | Team A

Time of Measurements**

Contaminated Roof & Ground 0835 (1 Feb 62)
Decontaminated Roof & Contaminated Ground 1105 (1 Feb 62)
Decontaminated Roof & Ground 1715 (1 Feb 62)

Temperatures
Decon. Roof 00F
Decon. Ground 120F

	Contaminated† Roof & Ground		Decontaminated Roof & Contaminated Ground			
	Radiation Level (mr/hr)		Radiation Level (mr/hr)		Residual Radiation (%)	
	Walls	Center	Walls	Center	Walls	Center
Top Floor	4.8	5.7	3.5	4.5	73	79
	4.6	5.0	4.0	3.5	87	70
	5.8	4.3	5.8	3.5	100	81
	6.2	4.0	4.8	3.5	77	88
	6.7		5.2		78	
Bottom Floor	4.3	4.8	4.0	4.8	93	100
	4.6	3.8	4.5	3.5	98	92
	6.5	3.8	6.5	3.5	100	92
	6.3	3.6	6.5	3.5	103	97
	6.7	3.9	6.6	3.5	99	90

	Contaminated† Roof & Ground		Decontaminated Roof & Decontaminated Ground			
	Radiation Level (mr/hr)		Radiation Level (mr/hr)		Residual Radiation (%)	
	Walls	Center	Walls	Center	Walls	Center
Top Floor	4.3	5.1	3.0	3.5	70	69
	4.1	4.5	2.0	2.0	49	44
	5.2	3.9	2.0	2.0	38	51
	5.5	3.6	2.0	1.5	36	42
	6.0		3.5		58	
Bottom Floor	3.9	4.3	2.0	3.0	51	70
	4.1	3.4	1.5	1.0	37	29
	5.8	3.4	1.0	1.5	17	44
	5.6	3.3	2.0	1.5	36	45
	6.0	3.4	1.5	1.5	25	44

*Roof decontaminated by hosing.
**Measurements taken 3 feet above floor with an Eberline Model E-200A radiation meter. See Figures F-4 and F-5 for location of readings.
† Value at time decontamination readings were taken.

TABLE F-10

LOGISTICS EXERCISE DECONTAMINATION DATA

SECTOR I

Building 506* - Interior | Team A

Time of Measurements**

Contaminated Roof & Ground 0835 (1 Feb 62)
Decontaminated Roof & Contaminated Ground 1105 (1 Feb 62)
Decontaminated Roof & Ground 1715 (1 Feb 62)

Temperatures
Decon. Roof 0°F
Decon. Ground 12°F

Contaminated† Roof & Ground		Decontaminated Roof & Contaminated Ground			
Radiation Level (mr/hr)		Radiation Level (mr/hr)		Residual Radiation (%)	
Walls	Center	Walls	Center	Walls	Center
7.7	7.2	7.0	6.0	91	83
7.7	7.7	6.0	5.0	78	65
7.7	6.7	13.0	5.5	170	82
7.2		8.0		111	
7.2		6.3		88	
7.7		8.8		114	
7.7		9.0		117	
7.7		14.0		182	
5.3		3.0		57	

Contaminated† Roof & Ground		Decontaminated Roof & Contaminated Ground			
Radiation Level (mr/hr)		Radiation Level (mr/hr)		Residual Radiation (%)	
Walls	Center	Walls	Center	Walls	Center
6.9	6.4	2.5	2.5	36	39
6.9	6.9	2.0	2.0	29	29
6.9	6.0	2.5	3.0	36	50
6.4		2.0		31	
6.4		2.5		39	
6.9		3.5		51	
6.9		2.5		36	
6.9		5.0		72	
4.7		1.5		32	

*Roof decontaminated by sweeping.
**Measurements taken 3 feet above floor with an Eberline Model E-200A radiation meter. See Figures F-4 and F-5 for location of readings.
† Value at time decontamination readings were taken.

TABLE F-11

LOGISTICS EXERCISE DECONTAMINATION DATA

SECTOR I

Building 505* - Interior

Team B

Time of Measurements**

Contaminated Roof & Ground 0835 (1 Feb 62)
Decontaminated Roof & Contaminated Ground 1105 (1 Feb 62)
Decontaminated Roof & Ground 1715 (1 Feb 62)

Temperatures

Decon. Roof $0^{o}F$
Decon. Ground $12^{o}F$

Contaminated† Roof & Ground		Decontaminated Roof & Contaminated Ground			
Radiation Level (mr/hr)		Radiation Level (mr/hr)		Residual Radiation (%)	
Walls	Center	Walls	Center	Walls	Center
6.3	5.8	2.8	3.6	44	62
5.8	5.3	12.0	3.4	207	64
6.3	6.7	5.0	5.0	79	75
5.8		5.5		95	
7.0		8.5		121	
6.3		5.5		87	
5.3		6.5		123	
5.3		4.0		75	
6.7		6.0		90	

Contaminated† Roof & Ground		Decontaminated Roof & Decontaminated Ground			
Radiation Level (mr/hr)		Radiation Level (mr/hr)		Residual Radiation (%)	
Walls	Center	Walls	Center	Walls	Center
5.6	5.2	1.0	3.0	18	58
5.2	4.7	2.0	1.5	38	32
5.6	6.0	1.5	2.0	27	33
5.2		1.5		29	
6.3		1.5		24	
5.6		2.0		36	
4.7		1.5		32	
4.7		2.0		43	
6.0		2.5		42	

*Roof decontaminated by sweeping.
**Measurements taken 3 feet above floor with an Eberline Model E-200A radiation meter. See Figures F-4 and F-5 for location of readings.
† Value at time decontamination readings were taken.

TABLE F-12

LOGISTICS EXERCISE DECONTAMINATION DATA

SECTOR I

Building 504* - Interior | Team B

Time of Measurements**

Contaminated Roof & Ground 0835 (1 Feb 62)
Decontaminated Roof & Contaminated Ground 1105 (1 Feb 62)
Decontaminated Roof & Ground 1715 (1 Feb 62)

Temperature
Decon. Roof 0°F
Decon. Ground 12°F

	Contaminated† Roof & Ground		Decontaminated Roof & Contaminated Ground			
	Radiation Level (mr/hr)		Radiation Level (mr/hr)		Residual Radiation (%)	
	Walls	Center	Walls	Center	Walls	Center
Top Floor	4.3	3.4	5.2	3.6	121	106
	4.3	3.4	5.0	3.6	116	106
	4.3	4.3	5.6	4.0	130	93
	4.3		4.5		105	
	3.4		3.6		106	
	3.4		3.0		88	
	3.4		3.6		106	
	3.4		3.8		112	
Bottom Floor	2.9	3.4	4.5	3.5	155	103
	2.9	2.9	4.5	3.0	155	103
	3.4	3.9	5.0	3.5	147	90
	3.4		5.5		162	
	3.8		6.5		171	
	3.4		3.8		112	
	2.9		4.0		138	

*Roof decontaminated by hosing.
**Measurements taken 3 feet above floor with an Eberline Model E-200A radiation meter. See Figures F-4 and F-5 for location of readings.
† Value at time decontamination readings were taken.

TABLE F-12 (cont'd)

LOGISTICS EXERCISE DECONTAMINATION DATA

SECTOR I

Building 504* - Interior Team B

	Contaminated† Roof & Ground		Decontaminated Roof & Decontaminated Ground			
	Radiation Level (mr/hr)		Radiation Level (mr/hr)		Residual Radiation (%)	
	Walls	Center	Walls	Center	Walls	Center
Top Floor	3.9	3.0	3.5	2.0	90	67
	3.9	3.0	3.0	2.0	77	67
	3.9	3.9	2.5	1.5	64	38
	3.9		2.0		51	
	3.0		1.5		50	
	3.0		2.0		67	
	3.0		3.0		100	
	3.0		2.5		83	
Bottom Floor	2.6	3.0	2.0	2.5	77	83
	2.6	2.6	2.0	1.5	77	58
	3.0	3.4	2.0	1.5	67	44
	3.0		1.5		50	
	3.4		1.5		44	
	3.0		1.5		50	
	2.6		2.0		77	

TABLE F-13

LOGISTICS EXERCISE DECONTAMINATION DATA

SECTOR II

Building 514* - Interior   Team A

Time of Measurements**

Contaminated Ground 1745 (1 Feb 62)   Temperature 26°F
Decontaminated Ground 1715 (2 Feb 62)

	Contaminated† Ground		Decontaminated Ground			
	Radiation Level (mr/hr)		Radiation Level (mr/hr)		Residual Radiation (%)	
	Walls	Center	Walls	Center	Walls	Center
Top Floor	6.6	5.0	1.5	1.2	23	24
	6.6	3.3	1.3	0.8	20	24
	6.6	4.0	1.2	0.7	18	18
	6.6	4.0	1.3	0.8	20	20
	2.7		0.9		33	
	2.7		1.0		37	
	3.3		1.1		33	
	2.7		1.1		41	
	2.7		1.0		37	
Bottom Floor	6.3	5.3	1.5	0.9	24	17
	6.6	3.3	1.1	0.8	17	24
	8.0	4.3	1.0	0.9	13	21
	5.3	5.3	1.1	1.0	21	19
	4.6		1.0		22	
	5.3		1.0		19	
	2.3		1.0		43	
	2.3		0.9		39	

*Roof was not contaminated.

**Measurements taken 3 feet above floor with an Eberline Model E-200A radiation meter. See Figure F-6 for location of readings.

†Value at time decontamination readings were taken.

TABLE F-14

LOGISTICS EXERCISE DECONTAMINATION DATA

SECTOR II

Building 516* - Interior   Team A

Time of Measurements**

Contaminated Roof & Ground 1745 (1 Feb 62)   Temperature 26°F
Decontaminated Roof & Ground 1825 (2 Feb 62)

Contaminated† Roof & Ground		Decontaminated Roof & Ground			
Radiation Level (mr/hr)		Radiation Level (mr/hr)		Residual Radiation (%)	
Walls	Center	Walls	Center	Walls	Center
3.3	5.9	1.2	1.2	36	20
5.9	5.5	1.0	1.0	17	18
6.5	5.2	2.2	1.0	34	19
7.3	7.8	1.2	1.1	16	14
7.8		1.3		17	
8.5		1.5		18	
7.8		1.7		22	
6.5		1.1		17	
4.2		1.0		24	
6.5		1.0		15	

*Roof decontaminated by sweeping.

**Measurements taken 3 feet above floor with an Eberline Model E-200A radiation meter. See Figure F-6 for location of readings.

†Value at time decontamination readings were taken.

TABLE F-15

LOGISTICS EXERCISE DECONTAMINATION DATA

SECTOR II

Building 517* - Interior — Team B

Time of Measurements**

Contaminated Ground 1745 (1 Feb 62) — Temperature 26°F

Decontaminated Ground 1825 (2 Feb 62)

Contaminated† Roof & Ground		Decontaminated Roof & Ground			
Radiation Level (mr/hr)		Radiation Level (mr/hr)		Residual Radiation (%)	
Walls	Center	Walls	Center	Walls	Center
5.2	4.5	1.3	0.9	25	20
3.9	5.5	0.8	1.0	21	18
5.2	6.5	1.0	1.0	19	15
5.9		1.5		25	
6.5		1.5		23	
8.5		1.0		12	
6.5		1.0		15	
6.5		1.0		15	
2.6		0.8		31	
6.5		1.0		15	

*Roof decontaminated by sweeping.

**Measurements taken 3 feet above floor with an Everline Model E-200A radiation meter. See Figure F-6 for location of readings.

†Value at time decontamination readings were taken.

TABLE F-16

LOGISTICS EXERCISE DECONTAMINATION DATA

SECTOR II

Building 518* - Interior Team B

Time of Measurements**

Contaminated Ground 1745 (1 Feb 62) Temperature 26°F

Decontaminated Ground 1825 (2 Feb 62)

	Contaminated† Ground		Decontaminated Ground			
	Radiation Level (mr/hr)		Radiation Level (mr/hr)		Residual Radiation (%)	
	Walls	Center	Walls	Center	Walls	Center
Top Floor	3.3	4.5	1.0	1.1	30	24
	3.3	3.3	0.5	0.5	15	15
	3.9	3.3	0.5	0.5	13	15
	4.5	4.2	0.5	0.5	11	12
	4.5		0.8		18	
	3.9		0.7		18	
	3.9		0.8		21	
	3.9		0.8		21	
	4.2		1.2		29	
Bottom Floor	4.5	6.5	0.6	1.3	13	20
	4.9	2.6	0.5	0.5	10	19
	7.2	3.5	0.8	0.5	11	14
	5.2	5.5	1.0	0.8	19	15
	3.9		0.8		21	
	3.3		0.6		18	
	3.9		0.8		21	
	3.3		1.0		30	

*Roof was not contaminated.

**Measurements taken 3 feet above floor with an Eberline Model E-200A radiation meter. See Figure F-6 for location of readings.

†Value at time decontamination readings were taken.

APPENDIX G

MIGRATION TEST DATA

Test data on the vertical and horizontal migration of simulated fallout are presented in this appendix. In order to trace the migration, a fluorescent - Liquifluor - was sprayed onto the sand used as the fallout. The extent of the migration was then determined by comparing the original concentration on the plot with the concentrations of Liquifluor measured at various depths, both on the plot and downwind from it.

The instrument used to measure the Liquifluor concentrations was the fluorometer. This instrument, which is sensitive to the amount of fluorescence of a material, was calibrated by measuring the output in μμamps of four known concentrations of Liquifluor in toluene (see figure G-1). The volume in each case was 14 ml.

The method of taking samples and preparing them for the fluorometer measurements is described in Section 4.4. In the tables following, the original Liquifluor concentration (before migration) is noted above the tabulated data. For each sample, the fluorometer reading, its corresponding Liquifluor concentration, and the percent of original concentration are given. The numbers in parentheses are the powers of 10.

TABLE G-1

VERTICAL MIGRATION OF FALLOUT THROUGH UNDISTURBED SNOW COVERED BY LOOSE SNOW

Original Concentration: 1.0(-4) parts by vol.*

Date of Deposition: 1-31-62
Time of Deposition: 1000

Time After Deposition (hr)	Depth of Sample (in.)	SAMPLE 1 Fluorometer Reading (amp)	SAMPLE 1 Liquifluor Conc. (parts by vol.)	SAMPLE 1 % of Orig. Conc.	SAMPLE 2 Fluorometer Reading (amp)	SAMPLE 2 Liquifluor Conc. (parts by vol.)	SAMPLE 2 % of Orig. Conc.	Average of Percents
24	0.0	2.1(-8)	3.65(-5)	36.5	2.0(-8)	3.45(-5)	34.5	35.5
	0.5	2.2(-8)	3.90(-5)	39.0	2.1(-8)	3.65(-5)	36.5	37.8
	1.0	7.4(-9)	6.50(-6)	6.5	7.6(-9)	6.90(-6)	6.9	6.7
	1.5	5.2(-9)	2.40(-6)	2.4	5.1(-9)	2.30(-6)	2.3	2.4
48	0.0	2.2(-8)	3.90(-5)	39.0	2.1(-8)	3.65(-5)	36.5	37.8
	0.5	2.1(-8)	3.65(-5)	36.5	2.0(-8)	3.45(-5)	34.5	35.5
	1.0	7.3(-9)	6.20(-6)	6.2	7.6(-9)	6.90(-6)	6.9	6.6
	1.5	5.3(-9)	2.55(-6)	2.6	5.4(-9)	2.70(-6)	2.7	2.7

* See Figure G-1

TABLE G-2

VERTICAL MIGRATION OF FALLOUT THROUGH UNDISTURBED SNOW

Original Concentration: 1.05(-4) parts by vol.*

Date of Deposition: 1-23-62
Time of Deposition: 0930

Time After Deposition (hr)	Depth of Sample (in.)	SAMPLE 1 Fluorometer Reading (amp)	SAMPLE 1 Liquifluor Conc. (parts by vol.)	SAMPLE 1 % of Orig. Conc.	SAMPLE 2 Fluorometer Reading (amp)	SAMPLE 2 Liquifluor Conc. (parts by vol.)	SAMPLE 2 % of Orig. Conc.	Average of Percents
24	0.0	2.1(-8)	3.65(-5)	34.8	2.0(-8)	3.45(-5)	32.9	33.9
	0.5	2.0(-8)	3.45(-5)	32.9	2.1(-8)	3.65(-5)	34.8	33.9
	1.0	7.0(-9)	5.60(-6)	5.3	6.9(-9)	5.50(-6)	5.2	5.3
	1.5	5.3(-9)	2.55(-6)	2.4	5.2(-9)	2.40(-6)	2.3	2.4
48	0.0	2.0(-8)	3.45(-5)	32.9	2.1(-8)	3.65(-5)	34.8	33.9
	0.5	2.1(-8)	3.65(-5)	34.8	2.2(-8)	3.90(-5)	37.1	36.0
	1.0	7.0(-9)	5.60(-6)	5.3	6.7(-9)	5.00(-6)	4.8	5.1
	1.5	5.2(-9)	2.40(-6)	2.3	4.9(-9)	2.00(-6)	1.9	2.1
72	0.0	7.0(-9)	5.60(-6)	5.3	-	-	-	5.3
	0.5	2.1(-8)	3.65(-5)	34.8	-	-	-	34.8
	1.0	2.0(-8)	3.45(-5)	32.9	-	-	-	32.9
	1.5	5.3(-9)	2.55(-6)	2.4	-	-	-	2.4

* See Figure G-1

TABLE G-3

VERTICAL MIGRATION OF FALLOUT THROUGH CRUSTED, UNDISTURBED SNOW

Original Concentration: 1.05(-4) parts by vol.*

Date of Deposition: 2-5-62
Time of Deposition: 1400

Time After Deposition (hr)	Depth of Sample (in.)	SAMPLE 1 Fluorometer Reading (amp)	SAMPLE 1 Liquifluor Conc. (parts by vol.)	SAMPLE 1 % of Orig. Conc.	SAMPLE 2 Fluorometer Reading (amp)	SAMPLE 2 Liquifluor Conc. (parts by vol.)	SAMPLE 2 % of Orig. Conc.	Average of Percents
4	0.0	2.8(-8)	5.2(-5)	49.5	-	-	-	49.5
	0.5	2.3(-8)	4.1(-5)	39.0	-	-	-	39.0
	1.0	7.4(-9)	6.5(-6)	6.2	-	-	-	6.2
	1.5	-	-	-	-	-	-	-
18	0.0	2.9(-8)	5.5(-5)	52.4	2.7(-8)	5.0(-5)	47.6	50.0
	0.5	2.2(-8)	3.9(-5)	37.1	2.6(-8)	4.8(-5)	45.7	41.4
	1.0	6.3(-9)	4.3(-6)	4.1	6.7(-9)	5.0(-6)	4.8	4.5
	1.5	-	-	-	-	-	-	-
24	0.0	2.8(-8)	5.2(-5)	49.5	2.6(-8)	4.8(-5)	45.7	47.6
	0.5	2.3(-8)	4.1(-5)	39.0	2.7(-8)	5.0(-5)	47.6	43.3
	1.0	6.3(-9)	4.3(-6)	4.1	6.2(-9)	4.0(-6)	3.8	4.0
	1.5	-	-	-	-	-	-	-
48	0.0	2.6(-8)	4.8(-5)	45.7	2.7(-8)	5.0(-5)	47.6	46.7
	0.5	2.5(-8)	4.5(-5)	42.9	2.6(-8)	4.8(-5)	45.7	44.3
	1.0	6.3(-9)	4.3(-6)	4.1	6.4(-9)	4.5(-6)	4.3	4.2
	1.5	-	-	-	-	-	-	-
72	0.0	2.5(-8)	4.5(-5)	42.9	2.6(-8)	4.8(-5)	45.7	44.3
	0.5	2.6(-8)	4.8(-5)	45.7	2.7(-8)	5.0(-5)	47.6	46.7
	1.0	6.3(-9)	4.3(-6)	4.1	6.6(-9)	4.9(-6)	4.7	4.4
	1.5	-	-	-	-	-	-	-

* See Figure G-1

TABLE G-4

VERTICAL MIGRATION OF FALLOUT THROUGH ICE

Original Concentration: 1.4(-5) parts by vol.*

Date of Deposition: 1-23-62
Time of Deposition: 1000

Time After Deposition (hr)	Depth of Sample (in.)	SAMPLE 1 Fluorometer Reading (amp)	SAMPLE 1 Liquifluor Conc. (parts by vol.)	SAMPLE 1 % of Orig. Conc.	SAMPLE 2 Fluorometer Reading (amp)	SAMPLE 2 Liquifluor Conc. (parts by vol.)	SAMPLE 2 % of Orig. Conc.	Average of Percents
24	0.0	5.1(-9)	2.30(-6)	16.4	5.2(-9)	2.40(-6)	17.1	16.8
	0.25	5.0(-9)	2.15(-6)	15.4	5.1(-9)	2.30(-6)	16.4	15.9
	0.50	4.1(-9)	1.10(-6)	7.9	4.0(-9)	1.00(-6)	7.1	7.5
	0.75	-	-	-	-	-	-	-
48	0.0	4.7(-9)	1.75(-6)	12.5	4.8(-9)	1.90(-6)	13.6	13.1
	0.25	4.9(-9)	2.00(-6)	14.3	4.9(-9)	2.00(-6)	14.3	14.3
	0.50	4.4(-9)	1.40(-6)	10.0	4.3(-9)	1.30(-6)	9.3	9.7
	0.75	-	-	-	-	-	-	-
72	0.0	4.7(-9)	1.75(-6)	12.5	4.7(-9)	1.75(-6)	12.5	12.5
	0.25	4.8(-9)	1.90(-6)	13.6	4.9(-9)	2.00(-6)	14.3	14.0
	0.50	4.3(-9)	1.30(-6)	9.3	4.4(-9)	1.40(-6)	10.0	9.7
	0.75	-	-	-	-	-	-	-

* See Figure G-1

TABLE G-5

HORIZONTAL MIGRATION OF FALLOUT THROUGH CRUSTED, UNDISTURBED SNOW
- AFTER 18 HOURS -

Original Concentration: 1.05(-4) parts by vol.*

Date of Deposition: 2-5-62
Time of Deposition: 1400

Distance From Plot (ft)	Depth of Sample (in.)	SAMPLE 1			SAMPLE 2			Average of Percents
		Fluorometer Reading (amp)	Liquifluor Conc. (parts by vol.)	% of Orig. Conc.	Fluorometer Reading (amp)	Liquifluor Conc. (parts by vol.)	% of Orig. Conc.	
0	0.0	2.9(-8)	5.5(-5)	52.4	2.7(-8)	5.0(-5)	47.6	50.0
	0.5	2.2(-8)	3.9(-5)	37.1	2.6(-8)	4.8(-5)	45.7	41.4
	1.0	6.3(-9)	4.3(-6)	4.1	6.7(-9)	5.0(-6)	4.8	4.5
	1.5	-	-	-	-	-	-	-
1	0.0	1.8(-8)	3.0(-5)	28.6	1.9(-8)	3.2(-5)	30.5	29.6
	0.5	7.6(-9)	6.9(-6)	6.6	7.2(-9)	6.0(-6)	5.7	6.2
	1.0	-	-	-	-	-	-	-
	1.5	-	-	-	-	-	-	-
2	0.0	7.4(-9)	6.5(-6)	6.2	7.8(-9)	7.3(-6)	7.0	6.6
	0.5	-	-	-	-	-	-	-
	1.0	-	-	-	-	-	-	-
	1.5	-	-	-	-	-	-	-
3	0.0	4.2(-9)	1.2(-6)	1.1	4.6(-9)	1.7(-6)	1.6	1.4
	0.5	-	-	-	-	-	-	-
	1.0	-	-	-	-	-	-	-
	1.5	-	-	-	-	-	-	-

* See Figure G-1

TABLE G-5 (cont'd)

HORIZONTAL MIGRATION OF FALLOUT THROUGH CRUSTED, UNDISTURBED SNOW
- AFTER 24 HOURS -

Original Concentration: 1.05(-4) parts by vol.*

Date of Deposition: 2-5-62
Time of Deposition: 1400

Distance From Plot (ft)	Depth of Sample (in.)	SAMPLE 1			SAMPLE 2			Average of Percents
		Fluorometer Reading (amp)	Liquifluor Conc. (parts by vol.)	% of Orig. Conc.	Fluorometer Reading (amp)	Liquifluor Conc. (parts by vol.)	% of Orig. Conc.	
0	0.0	2.8(-8)	5.2(-5)	49.5	2.6(-8)	4.8(-5)	45.7	47.6
	0.5	2.3(-8)	4.1(-5)	39.0	2.7(-8)	5.0(-5)	47.6	43.3
	1.0	6.3(-9)	4.3(-6)	4.1	6.2(-9)	4.0(-6)	3.8	4.0
	1.5	-	-	-	-	-	-	-
1	0.0	1.8(-8)	3.0(-5)	28.6	1.8(-8)	3.0(-5)	28.6	28.6
	0.5	7.7(-9)	7.0(-6)	6.7	7.9(-9)	7.5(-6)	7.1	6.9
	1.0	-	-	-	-	-	-	-
	1.5	-	-	-	-	-	-	-
2	0.0	7.4(-9)	6.5(-6)	6.2	7.6(-9)	6.9(-6)	6.6	6.4
	0.5	-	-	-	-	-	-	-
	1.0	-	-	-	-	-	-	-
	1.5	-	-	-	-	-	-	-
3	0.0	4.2(-9)	1.2(-6)	1.1	4.4(-9)	1.4(-6)	1.3	1.2
	0.5	-	-	-	-	-	-	-
	1.0	-	-	-	-	-	-	-
	1.5	-	-	-	-	-	-	-

* See Figure G-1

TABLE G-5 (cont'd)

HORIZONTAL MIGRATION OF FALLOUT THROUGH CRUSTED, UNDISTURBED SNOW
- AFTER 48 HOURS -

Original Concentration: 1.05(-4) parts by vol.*

Date of Deposition: 2-5-62
Time of Deposition: 1400

Distance From Plot (ft)	Depth of Sample (in.)	SAMPLE 1			SAMPLE 2			Average of Percents
		Fluorometer Reading (amp)	Liquifluor Conc. (parts by vol.)	% of Orig. Conc.	Fluorometer Reading (amp)	Liquifluor Conc. (parts by vol.)	% of Orig. Conc.	
0	0.0	2.6(-8)	4.8(-5)	45.7	2.7(-8)	5.0(-5)	47.6	46.7
	0.5	2.5(-8)	4.5(-5)	42.9	2.6(-8)	4.8(-5)	45.7	44.3
	1.0	6.3(-9)	4.3(-6)	4.1	6.4(-9)	4.5(-6)	4.3	4.2
	1.5	-	-	-	-	-	-	-
1	0.0	1.7(-8)	2.8(-5)	26.7	1.6(-8)	2.5(-5)	23.8	25.3
	0.5	8.1(-9)	8.0(-6)	7.6	7.9(-9)	7.5(-6)	7.1	7.4
	1.0	-	-	-	-	-	-	-
	1.5	-	-	-	-	-	-	-
2	0.0	7.3(-9)	6.2(-6)	5.9	7.5(-9)	6.6(-6)	6.3	6.1
	0.5	4.1(-9)	1.1(-6)	1.0	4.0(-9)	1.0(-6)	1.0	1.0
	1.0	-	-	-	-	-	-	-
	1.5	-	-	-	-	-	-	-
3	0.0	4.1(-9)	1.1(-6)	1.0	4.0(-9)	1.0(-6)	1.0	1.0
	0.5	-	-	-	-	-	-	-
	1.0	-	-	-	-	-	-	-
	1.5	-	-	-	-	-	-	-

* See Figure G-1

TABLE G-5 (cont'd)

HORIZONTAL MIGRATION OF FALLOUT THROUGH CRUSTED, UNDISTURBED SNOW
- AFTER 72 HOURS -

Original Concentration: 1.05(-4) parts by vol.*

Date of Deposition: 2-5-62
Time of Deposition: 1400

Distance From Plot (ft)	Depth of Sample (in.)	SAMPLE 1			SAMPLE 2			Average of Percents
		Fluorometer Reading (amp)	Liquifluor Conc. (parts by vol.)	% of Orig. Conc.	Fluorometer Reading (amp)	Liquifluor Conc. (parts by vol.)	% of Orig. Conc.	
0	0.0	2.5(-8)	4.5(-5)	42.9	2.6(-8)	4.8(-5)	45.7	44.3
	0.5	2.6(-8)	4.8(-5)	45.7	2.7(-8)	5.0(-5)	47.6	46.7
	1.0	6.3(-9)	4.3(-6)	4.1	6.6(-9)	4.9(-6)	4.7	4.4
	1.5	-	-	-	-	-	-	-
1	0.0	1.6(-8)	2.5(-5)	23.8	1.4(-8)	2.1(-5)	20.0	21.9
	0.5	9.2(-9)	1.0(-5)	9.5	9.6(-9)	1.1(-5)	10.5	10.0
	1.0	-	-	-	-	-	-	-
	1.5	-	-	-	-	-	-	-
2	0.0	7.2(-9)	6.0(-6)	5.7	7.1(-9)	5.9(-6)	5.6	5.7
	0.5	4.3(-9)	1.3(-6)	1.2	5.2(-9)	2.4(-6)	2.3	1.8
	1.0	-	-	-	-	-	-	-
	1.5	-	-	-	-	-	-	-
3	0.0	4.0(-9)	1.0(-6)	1.0	4.1(-9)	1.1(-6)	1.0	1.0
	0.5	-	-	-	-	-	-	-
	1.0	-	-	-	-	-	-	-
	1.5	-	-	-	-	-	-	-

* See Figure G-1

TABLE G-6

HORIZONTAL MIGRATION OF FALLOUT THROUGH UNDISTURBED SNOW
- AFTER 24 HOURS -

Original Concentration: 1.05(-4) parts by vol.*

Date of Deposition: 1-23-62
Time of Deposition: 0930

Distance From Plot (ft)	Depth of Sample (in.)	SAMPLE 1			SAMPLE 2			SAMPLE 3			Average of Percents
		Fluorometer Reading (amp)	Liquifluor Conc.*	% of Orig. Conc.	Fluorometer Reading (amp)	Liquifluor Conc.*	% of Orig. Conc.	Fluorometer Reading (amp)	Liquifluor Conc.*	% of Orig. Conc.	
0	0.0	2.1(-8)	3.65(-5)	34.8	2.0(-8)	3.45(-5)	32.9	-	-	-	33.9
	0.5	2.0(-8)	3.45(-5)	32.9	2.1(-8)	3.65(-5)	34.8	-	-	-	33.9
	1.0	7.0(-9)	5.60(-6)	5.3	6.9(-9)	5.50(-6)	5.2	-	-	-	5.3
	1.5	5.3(-9)	2.55(-6)	2.4	5.2(-9)	2.40(-6)	2.3	-	-	-	2.4
1	0.0	1.9(-8)	3.20(-5)	30.5	2.0(-8)	3.45(-5)	32.9	1.8(-8)	3.00(-5)	28.6	30.7
	0.5	7.0(-9)	5.60(-6)	5.3	7.8(-9)	7.30(-6)	7.0	7.6(-9)	6.90(-6)	6.6	6.3
	1.0	4.0(-9)	1.00(-6)	1.0	4.8(-9)	1.90(-6)	1.8	4.1(-9)	1.10(-6)	1.0	1.3
	1.5	4.1(-9)	1.10(-6)	1.0	-	-	-	3.7(-9)	-	-	1.0
2	0.0	8.9(-9)	9.80(-6)	9.3	8.6(-9)	9.00(-6)	8.6	9.2(-9)	1.05(-5)	10.0	9.3
	0.5	4.1(-9)	1.10(-6)	1.0	4.3(-9)	1.30(-6)	1.2	5.4(-9)	2.70(-6)	2.6	1.6
	1.0	-	-	-	-	-	-	-	-	-	-
	1.5	-	-	-	-	-	-	-	-	-	-
3	0.0	4.2(-9)	1.20(-6)	1.1	4.6(-9)	1.65(-6)	1.6	4.4(-9)	1.40(-6)	1.3	1.3
	0.5	-	-	-	-	-	-	-	-	-	-
	1.0	-	-	-	-	-	-	-	-	-	-
	1.5	-	-	-	-	-	-	-	-	-	-

* See Figure G-1

TABLE G-6 (cont'd)

HORIZONTAL MIGRATION OF FALLOUT THROUGH UNDISTURBED SNOW
- AFTER 48 HOURS -

Original Concentration: 1.05(-4) parts by vol.*

Date of Deposition: 1-23-62
Time of Deposition: 0930

Distance From Plot (ft)	Depth of Sample (in.)	SAMPLE 1 Fluorometer Reading (amp)	SAMPLE 1 Liquifluor Conc.*	SAMPLE 1 % of Orig. Conc.	SAMPLE 2 Fluorometer Reading (amp)	SAMPLE 2 Liquifluor Conc.	SAMPLE 2 % of Orig. Conc.	SAMPLE 3 Fluorometer Reading (amp)	SAMPLE 3 Liquifluor Conc.	SAMPLE 3 % of Orig. Conc.	Average of Percents
0	0.0	2.0(-8)	3.45(-5)	32.9	2.1(-8)	3.65(-5)	34.8				33.9
	0.5	2.1(-8)	3.65(-5)	34.8	2.2(-8)	3.90(-5)	37.1				36.0
	1.0	7.0(-9)	5.60(-6)	5.3	6.7(-9)	5.00(-6)	4.8				5.1
	1.5	5.2(-9)	2.40(-6)	2.3	4.9(-9)	2.00(-6)	1.9				2.1
1	0.0	1.0(-8)	1.20(-5)	11.4	1.1(-8)	1.40(-5)	13.3	1.2(-8)	1.65(-5)	15.7	13.5
	0.5	7.4(-9)	6.50(-6)	6.2	7.3(-9)	6.20(-6)	5.9	7.1(-9)	5.90(-6)	5.6	5.9
	1.0	4.8(-9)	1.90(-6)	1.8	4.1(-9)	1.10(-6)	1.0	4.6(-9)	1.65(-6)	1.6	1.5
	1.5	4.0(-9)	1.00(-6)	1.0	-	-	-	3.6(-9)	-	-	1.0
2	0.0	5.3(-9)	2.55(-6)	2.4	5.6(-9)	3.00(-6)	2.9	6.2(-9)	4.00(-6)	3.8	3.0
	0.5	7.8(-9)	7.30(-6)	7.0	7.4(-9)	6.50(-6)	6.2	5.3(-9)	2.55(-6)	2.4	5.2
	1.0	4.6(-9)	1.65(-6)	1.6	4.7(-9)	1.75(-6)	1.7	4.2(-9)	1.20(-6)	1.1	1.5
	1.5	-	-	-	-	-	-	-	-	-	-
3	0.0	-	-	-	-	-	-	-	-	-	-
	0.5	4.3(-9)	1.30(-6)	1.2	4.8(-9)	1.90(-6)	1.8	4.6(-9)	1.65(-6)	1.6	1.5
	1.0	-	-	-	-	-	-	-	-	-	-
	1.5	-	-	-	-	-	-	-	-	-	-

*See Figure G-1

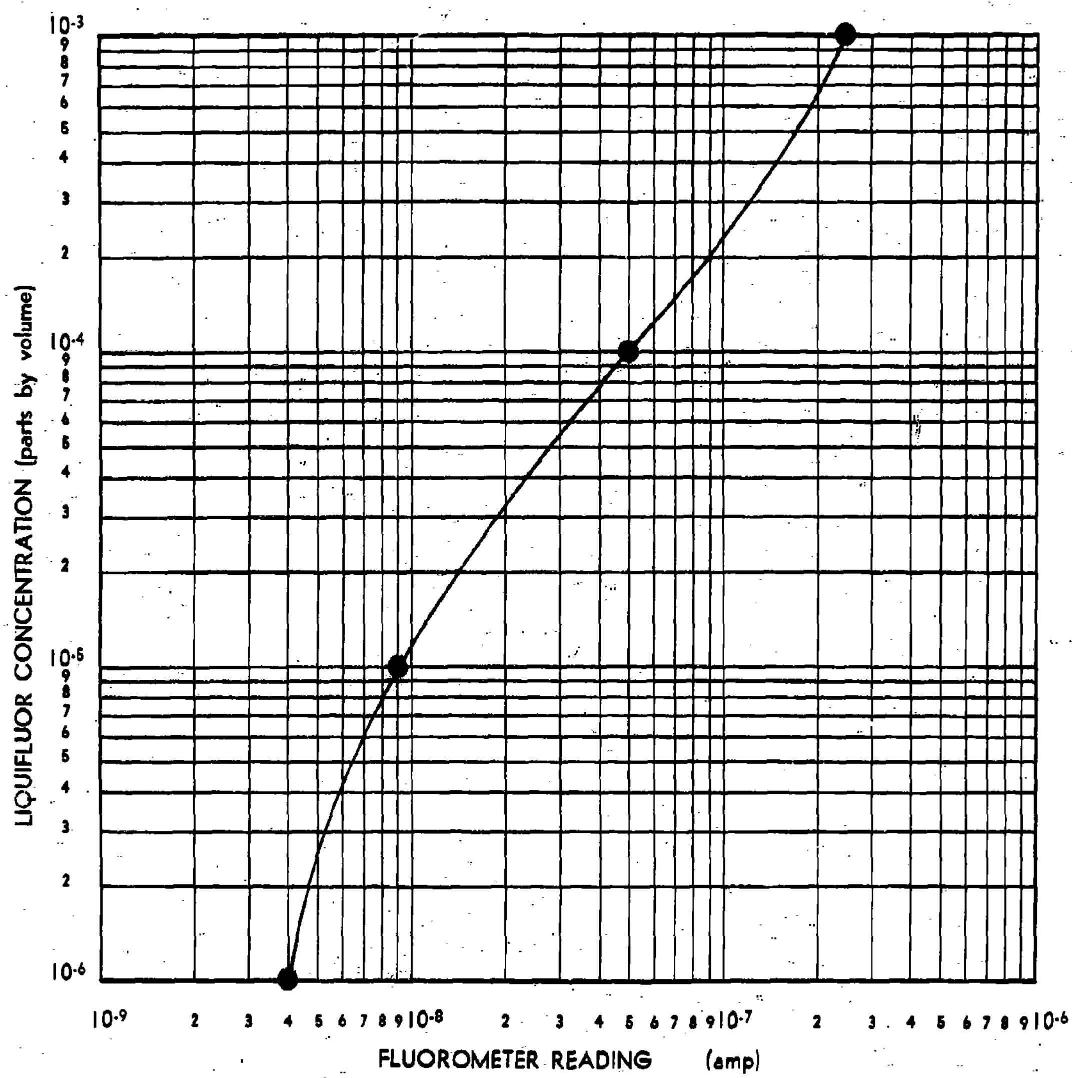

FIGURE G-1 FLUOROMETER STANDARDIZATION CURVE FOR LIQUIFLUOR CONCENTRATIONS

APPENDIX H

ANALYSIS OF DATA

H-1. Percentage Decontamination of Test Plots.

Test-plot radiation measurements were taken with detection and associated electronic equipment which converted the radiation intensity at the detection element directly into electric current of about 100 micromicroamperes. In this system, the current readout was directly proportional to the radiation intensity, which allowed calculation of decontamination percentages from current measurements without resorting to conversion of electrical current into radiation intensity units.

Each test plot was scanned across its 20-foot dimension at 10-foot intervals. The current measurement was recorded on an X-Y recorder versus the detector's relative position over the test plot. A set of measurement scans were taken before and after decontamination with each of the scan positions being the same for each set. Prior to each test, background measurements were taken.

The area of the recorded trace of current versus detector position of each scan was measured with a planimeter, and the corresponding area of the background measurement was subtracted. The result is an integrated factor which is proportional function of the average radiation intensity across the test plot.

The percentages of decontamination given in this report are defined by the equation

$$\% \text{ Decontamination} = \frac{I_c - I_d}{I_c} (100) \qquad (1)$$

where

I_c = radiation intensity of contaminated area

I_d = radiation intensity of decontaminated area

Since the factors obtained from field measurements are directly proportional to the radiation intensities, the percentages of decontamination of the portion of the test plot under each scan may be calculated by

$$\% \text{ Decontamination} - \left(\frac{F_c - F_d}{F_c} \right) (100) = \left[1 - \frac{F_d}{F_c} \right] (100) = D \qquad (2)$$

where

F_c = integrated factor of scan over contaminated plot less background

F_d = integrated factor of scan over decontaminated plot less background

There were from 5 to 11 scan positions for each test area. A percentage of decontamination was calculated for each scan position. These, along with the areas of the X-Y recorder graphs, presented in tables E-1 through E-42.

The average percentage of decontamination was calculated in the usual way by taking the arithmetic mean, which is

$$\text{Average \% decontamination} = \frac{\sum_{1}^{N} D_k}{N} \tag{3}$$

where

D_k = percentage of decontamination of the k^{th} scan position

N = number of scan positions in set

The variances of the percentages of decontamination about their average may also be estimated for the data. Since each scan position percentage is independent of other positions, and highly dependent upon contaminant level in the immediate vicinity of its position, the variation in decontamination percentages would reflect primarily the variation in decontamination effectiveness and not variation in the original contamination level. This supposition is enhanced by the facts that (1) the detection element was shielded with a collimator, and (2) the basic data are integrated values over 20-foot lengths. It must be assumed that variation in decontamination effectiveness is independent of contaminant mass level over the mass level ranges used in the tests.

In the tabulated data, a confidence interval is given for each average percentage of decontamination. This interval is based on a 90% confidence level, and is a measure of the variation of decontamination effectiveness and experimental error. Determination of experimental error would have required repetition of experiment, but the error, relative to variations of decontamination effectiveness, was probably small. Therefore, the presented confidence intervals will represent the range of decontamination percentage about the calculated average which will

have a probability of 0.9 of containing the true percentages. The confidence intervals were calculated with the following equations:

$$S = \pm \sqrt{\frac{\sum_{1}^{N} D_k^2 - \frac{\left(\sum_{1}^{N} D_k\right)^2}{N}}{(N-1)}} \tag{4a}$$

$$C.I. = \pm \frac{tS}{\sqrt{N}} \tag{4b}$$

where

S = Standard deviation

C.I. = confidence interval

$\sum_{1}^{N} D_k^2$ = summation of squares of each scan decontamination percentage

$\sum_{1}^{N} D_k$ = summation of scan decontamination percentage

N = number of scans in set

t = student's t statistic

The standard deviation is divided by the $\sqrt{N}$ for the determination of the confidence interval as each scan's decontamination percentage is an average statistic, allowing use of the t statistic. The values of t for sample sizes of 5 to 11 at a 90% confidence level are:

Number of scans	Percentages of t distribution
5	2.132
6	2.015
7	1.943
8	1.895
9	1.860
10	1.833
11	1.812

In test data, when single point measurements were taken, such as roof radiation measurements and sand activity and weight, the confidence intervals were determined by using the equation

$$\text{Confidence interval} = \pm 1.645\ S \qquad (5)$$

H-2. Regression Analyses of Percentage Decontamination.

In addition to the analyses designed to determine the amount of decontamination affected in each of the various tests, it is also of value to determine the movement, if any, of the contamination over the test plot as it is being decontaminated. Regression analyses were performed on the test data to detect any such tendencies of the decontamination percentage to be dependent upon the test-area position.

Regression analyses consist of assuming that the response of experimental measurements is a function of some controlled independent variable. A mathematical model is so constructed and then tested for significance. For such analyses to be meaningful, the mathematical model must be significantly better than the original data, and there must be reason for response dependence.

In the regression analyses of this report, the dependence of the decontamination percentages on the scan position is determined. Such analyses can be conducted only where the direction of the decontamination operation is the same for the entire width of the test plot. Such procedure was used in the field tests for the motor grader, blade and rotary snow plows, towed scraper, and fire hosing.

The procedure for regression analysis begins by calculating the slope of the curve (assumed to be a straight line) of the independent variable, scan position, versus the dependent variable, percentage of decontamination. Although different in principle, the formulas are identical to those for calculating a least squares line. The second step is to determine the significance of the calculated slope, which is actually testing the dependence of the percentage of decontamination on the position. Regression analyses of this type is based on the t statistic, and the 90% level of confidence is used.

The regressions analyses of the test areas were determined in the following manner:

a. Calculations of the basic parameters, using the equations

$$\sum_{1}^{N} P = 1 + 2 + 3 + \dots + N \qquad (6)$$

$$\sum_1^N D = D_1 + D_2 + D_3 + \dots + D_N \tag{7}$$

$$\sum_1^N P_k D_k = 1D_1 + 2D_2 + 3D_3 + \dots + ND_N \tag{8}$$

$$\sum_1^N P_k^2 = 1^2 + 2^2 + 3^2 + \dots + N^2 \tag{9}$$

$$\sum_1^N D_1^2 = D_1^2 + D_2^2 + D_3^2 + \dots + D_N^2 \tag{10}$$

where

P = scan position number

D = scan decontamination percentage

N = number of scans per plot

b. Calculations of variances of the above parameters

$$S_P^2 = \frac{\sum_1^N P_k^2 - \frac{\left(\sum_1^N P_k\right)^2}{N}}{N-1} \tag{11}$$

$$S_D^2 = \frac{\sum_1^N D_k^2 - \frac{\left(\sum_1^N D\right)^2}{N}}{N-1} \tag{12}$$

c. Calculation of slope, b, of regression line

$$b = \frac{\sum_1^N P_k D_k - \frac{\sum_1^N P_k \sum_1^N D_k}{N}}{\sum_1^N P_k^2 - \frac{\left(\sum_1^N P_k\right)^2}{N}} \tag{13}$$

d. Calculation of variance of regression line

$$S_{D-P}^2 = \left(\frac{N-1}{N-2}\right)\left(S_D^2 - b^2\ S_P^2\right) \tag{14}$$

e. Calculation of t statistic

$$t = \frac{bS_p \sqrt{N-1}}{S_{D-P}} \qquad (15)$$

f. Calculation of intercept, a, of the regression line

$$a = \frac{\sum_{1}^{N} D_k}{N} - \frac{b \sum_{1}^{N} P_k}{N} \qquad (16)$$

g. Formula for regression line

$$D = a + bP \qquad (17)$$

The above calculated value of t is then compared with values from a table of t distribution values for (N-2) degrees of freedom at the 90% level of confidence. If the calculated value exceeded the value from the t table, there is sufficient reason to say that the line of regression is significant, and, therefore, percentage of decontamination is dependent upon relative position on the test plot. It should be noted that the variance of the percentage of decontamination, S_p^2, is the square of the standard deviation of the Average Percent Decontamination, given in the previous section. When this standard deviation is large, signifying very uneven decontamination, it will tend to conceal the significance of the regression slope, if it does exist.

The purpose of regression analyses of these data is to give some indication of area limits for which a particular type of decontamination is effective and feasible. A large regression slope means that a great amount of the contaminant is not being picked up or pushed aside, but instead is being carried forward by the decontamination apparatus, causing the apparatus to become less and less effective as it progresses.

In a few of the tests, regression analyses were performed across the plot. Data was obtained by dividing a central scan into 14 parts. These analyses indicate any lateral movement of contaminant, which is to be expected in many of the tests.

H-3. <u>Calculation of Test Area Activity Level</u>.

To determine the activity and mass levels of the simulant fallout on the test areas, shallow sampling pans were placed on the area prior to dissemination and removed before decontamination. The

sand collected in these pans was weighed and measured for specific activity. The results were reported as grams-per-square-foot mass level and microcuries-per-gram specific activity. An average and a standard deviation were calculated for each set from a test area.

The calculation of the activity level on the test area is simply the product of the averages of the mass level and specific activity, which results in microcuries per square foot.

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Joseph C. Maloney, John L. Meredith, James Barnard, and Charles C. Kilmer

NDL-TR-32, July 1962
Project 4X12-01-001-02, UNCLASSIFIED Report

The objective of this work was to obtain data on the efficiency of decontamination techniques under below-freezing conditions when applied to outdoor surfaces. Fallout simulant was prepared by tagging 150μ to 300μ sand with lanthanum-140. The simulant was then dispersed onto snow, frozen soil, and roof surfaces. The techniques of fire hosing, snow plowing, and power sweeping were tested on 20' x 100' plots and a 4-acre living quarters complex. Data was obtained on decontamination effectiveness, work and dose rates, and fallout migration.

1. Decontamination
2. Radioactive Fallout
3. Climate, Cold
4. Engineer Equipment

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